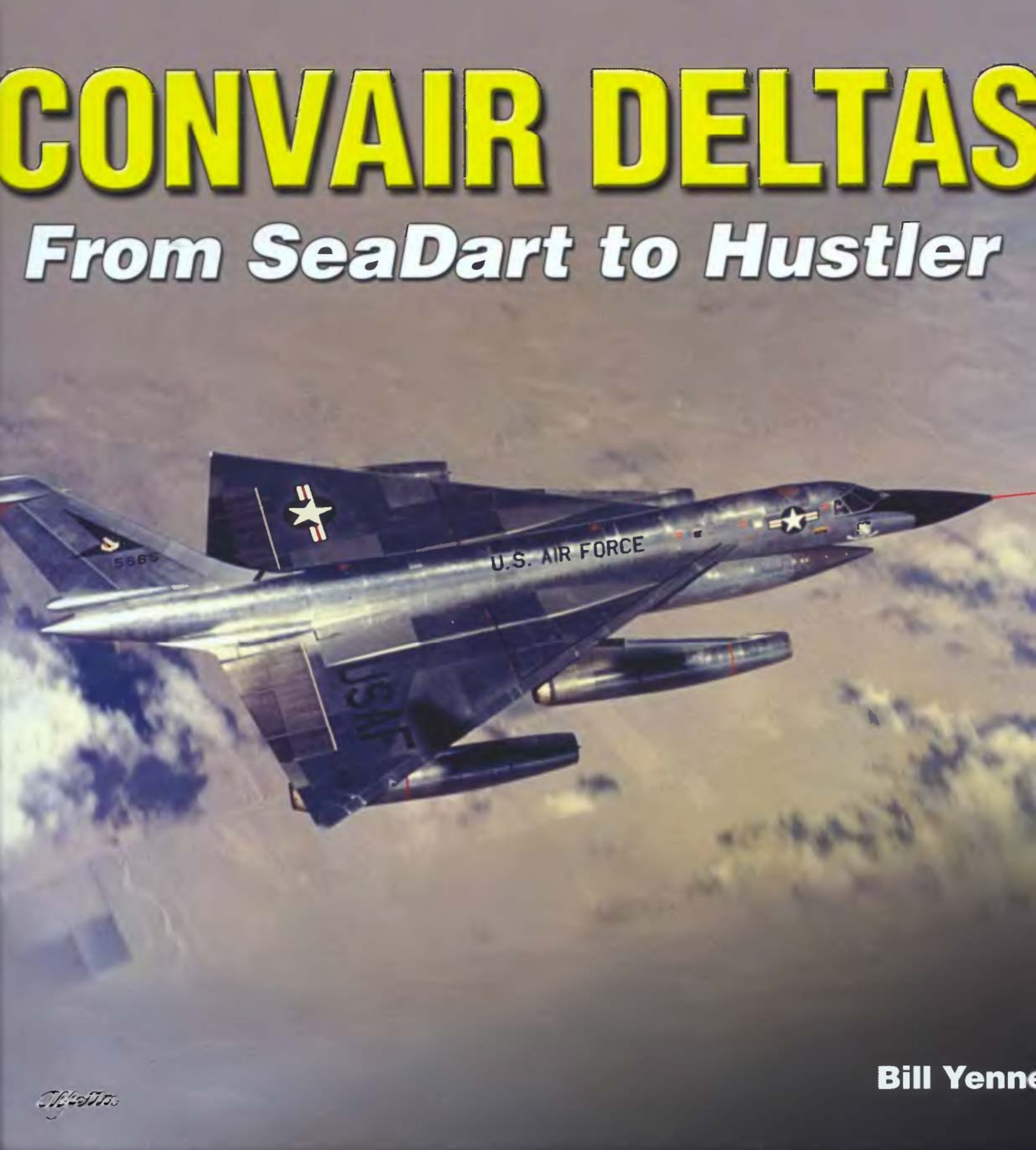
CONVAIR DELTAS

From SeaDart to Hustler



Bill Yenne

CONVAIR DELTAS

From SeaDart to Hustler

Bill Yenne

specialty press
PUBLISHERS AND WHOLESALERS

Specialty Press
39966 Grand Avenue
North Branch, MN 55056
Phone: 651-277-1400 or 800-895-4585
Fax: 651-277-1203
www.specialtypress.com

Edit by Dennis Jenkins
Layout by Monica Bahr

ISBN 978-1-58007-118-5
Item No. SP118

Library of Congress Cataloging-in-Publication Data

Yenne, Bill
Convair Deltas : from Seadart to Hustler / by Bill Yenne.
p. cm.
Includes bibliographical references and index.
ISBN 978-1-58007-118-5 (alk. paper)
1. Delta Dagger (Jet fighter plane)—History. 2. Delta Dart (Jet fighter plane)—History. 3. United States. Air Force—Equipment—History. I. Title.
UG1242.F5Y46 2009
623.74'6044—dc22

2009002302

Printed in China
10 9 8 7 6 5 4 3 2 1

On the Front Cover
King of the Convair Deltas, the mighty Mach 2 B-58 Hustler was a pinnacle of modern aeronautical engineering and represented the culmination of all the pioneering delta-wing designs that came before it. First flown by Convair's Chief Test Pilot, Beryl A. Erickson, the B-58 allowed Erickson to claim the unique distinction of becoming the world's first pilot to log 100 hours of supersonic flight time! *(U.S. Air Force photo)*

On the Title Page
Short, stubby, and as futuristic as it got during the early 1950s, the delta-wing XFY-1 Pogo was Convair's lone attempt at designing a vertical take-off and landing fighter plane that actually took to the skies. Powered by the ever-problematic Allison T-40 turboprop engine geared to twin contra-rotating propellers, the Pogo became the only tail-sitting VTOL design to make the transition from vertical to horizontal flight and back again to a vertical landing. *(Convair via Author's collection)*

On the Front Flap
The airplane that started it all, Convair's one-of-a-kind research prototype XF-92A served to validate Convair engineers who proclaimed the delta shape as being the most efficient high-performance wing planform available for use on a high-speed jet-powered aircraft. Anyone who has flown at Mach 2 as a passenger on the Concorde would be able to attest to that fact. *(Convair via Author's collection)*

On the Back Cover (top left)
Another view of the XF-92A, but wearing its original factory roll-out bare-metal color scheme as seen on the airplane's first flight at the Air Force Flight Test Center at Muroc, California, on 18 September 1948. Originally designed as a radical rocket-powered interceptor called the XF-92, the redesignated jet-powered XF-92A eventually expanded its flight envelope to reach speeds of more than 600 mph, and provided invaluable flight-test data for later Convair deltas. *(Convair via Author's collection)*

On the Back Cover (top right)
The business end of Convair's F-102A Delta Dagger can be seen here as this Deuce launches a bevy of Hughes AIM-4D Falcon radar-homing air-to-air missiles. Convair's first supersonic airplane, the F-102A was an outgrowth of the subsonic YF-102, and utilized the then-revolutionary design feature of a Coke-bottle-shaped "Area Ruled" fuselage, as can be seen here. Powered by a single Pratt & Whitney J-57 turbojet with afterburner, the F-102A was capable of speeds in excess of Mach 1.2. *(Convair via Author's collection)*

On the Back Cover (bottom right)
Looking like something right out of a 1950s' model airplane boxtop illustration, this Convair F-106A sits on the lakebed at Edwards AFB, California, resplendent in its bright red-orange flight-test color scheme. A sister ship to this particular airplane flown by Air Force Col. Joe Rogers set a world speed record of 1,525.95 mph on 15 December 1959. Although later broken by twin-engined jets, that mark stands to this day as the fastest speed ever achieved by a single-engine jet aircraft in level flight. *(Convair via Author's collection)*

Distributed in the UK and Europe by
Crécy Publishing Ltd
1a Ringway Trading Estate
Shadowmoss Road
Manchester M22 5LH England
Tel: 44 161 499 0024
Fax : 44 161 499 0298
www.crecy.co.uk
enquiries@crecy.co.uk

TABLE OF CONTENTS

Acknowledgments

For supplying photos that were vital in making this book what it is, I wish to thank Patrick J. McGee, David Menard, Erik Simonsen, and Allen B. Ury. A special nod of appreciation goes to Joe Sutila, who shared both his photos and personal experiences as an F-102A pilot in Southeast Asia. Thanks also to Gerry Cox, Larry Davis, Joe DeBlanc, Pat Gayton, Barbara McDonald, and Art Veitch at Convair for the help they provided on my earlier history of the company. The information and material that they supplied then were also important to this book.

About the Author

Bill Yenne is the San Francisco-based author of more than two-dozen books on military, aviation, and historical topics. Among his other projects, he was commissioned by General Dynamics Corporation to write a history of its Convair Division, which was entitled *Into The Sunset: The Convair Story*. The book earned Mr. Yenne congratulations and praise from the San Diego Air & Space Museum. In thanking Mr. Yenne for the work, General Dynamics called it "marvelous." In addition to his work on Convair, he has written corporate histories of America's other great plane makers, specifically Boeing, Lockheed, McDonnell Douglas, and North American Aviation. He is an occasional contributor to *International Air Power Review*, in whose pages he has profiled the Convair B-58 Hustler.

Mr. Yenne's other works include *Aces: True Stories of Victory & Valor in the Skies of World War II, Secret Weapons of the Cold War, Secret Weapons of World War II, The History of the U.S. Air Force*, and *SAC: A Primer of Strategic Air Power.* Of the latter, Maj. Michael Perini wrote in *Air Force Magazine:* "This book deserves a place on any airman's bookshelf and in the stacks of serious military libraries."

Mr. Yenne worked with the legendary Air Force commander, Gen. Curtis E. LeMay, to produce the recently re-released *Superfortress: The B-29 and American Airpower in World War II*, which *Publisher's Weekly* described as "an eloquent tribute." *FlyPast*, the UK's leading aviation monthly, said that his *The American Aircraft Factory in World War II* "knits a careful narrative around the imagery." His recent biography *Sitting Bull* was named to Amazon's Top 100 Best Books of 2008, placing it at Numer 14 (or Number 5 for non-fiction). *The New Yorker* writes that the book "excels as a study in leadership."

The Wall Street Journal has called one of Mr. Yenne's military histories "splendid" and went on to say that it "has the rare quality of being both an excellent reference work and a pleasure to read." The reviewer also wrote that Yenne writes with "cinematic vividness."

For more information, visit www.billyenne.com.

Nothing says "Guardian of Liberty" better than this classic Ren Wicks illustration that captures the image of the Convair F-102 Delta Dagger with key symbols of the country the delta interceptors were designed to defend. Convair was on the leading edge of American interceptor development and deployment for the first quarter century of the jet age. (Author's collection)

Introduction: Delta Wings?

"A 60 degree delta wing will be investigated this week."
(From a memo circulated among the staff of Adolph Burstein, Convair chief of design on 5 July 1946)

Indeed, what are "delta wings?" In the 1950s, aircraft that had them were, from a layman's perspective, the epitome of sleekness and futuristic design. At least that's how they appeared to the young boys of my generation. Technically, they were not that far off.

In its definitive form, a delta-winged aircraft is an aircraft whose wings form an isosceles triangle in the shape of the Greek letter "delta," with no horizontal tail surfaces. As viewed from above or below, the wing appears purely triangular. Various aircraft manufacturers—from Avro in Britain to Saab in Sweden—produced notable delta-winged aircraft through the decades that began with the 1950s. However, for two plane makers in particular, the pure delta wing became the signature design feature for large numbers of jet-propelled military aircraft. These were, first, Convair in the United States, and later, Dassault in France. Other aircraft from other manufacturers have been designed with triangular wings plus horizontal tail surfaces, and/or with triangular wings whose sides were not straight lines—as they were in the signature Convair and Dassault delta jets.

In the early days of entering service, the dart-like, delta-winged aircraft did indeed embody an appearance that was often described as "sleek" and "futuristic." Again, from a layman's perspective, they looked fast, and they looked like the future. Because of these characteristics, real delta-winged aircraft had been preceded by delta-winged aircraft in science fiction. Like flying wings, electronic brains, death rays, or Dick Tracy's wrist television, they existed as science fiction fantasy—and as toys—before the real thing became a practical reality. If you flip through the pop science magazines of the 1930s, you see all of these things—and more—vividly illustrated as the wonders of some fanciful future world that only the most imaginative could visualize.

Of course, many of the elements of early-twentieth-century science fiction became reality in the late twentieth century. Electronic brains became a practical reality in the 1950s, and they were on everyone's desktop within a generation. Death rays have become reality in the form of particle beam weapons and high-energy lasers. These are still what you would call experimental, but as for Dick Tracy's wrist television, we are surrounded by people who make and watch video on their cell phones, and it is now possible to watch full-length movies on hand-held devices. Both massive flying wings and delta-winged jets were the stuff of pop science in the 1930s that became a reality less than two decades later. In the case of flying wings, Northrop produced 14 XB-35 and YB-35 piston engine flying wing bombers for the Air Force in the late 1940s. Of these, three were later re-engined with turbojets under the YB-49 and YRB-49 designations.

In fact, delta-winged flying machines were firing imaginations before the golden age of pulp science fiction, and perhaps even before people began flying in winged vehicles. Innovations in aeronautical technology often originate as toys. Rotary-wing flying toys existed in the nineteenth century. Indeed, Wilbur and Orville Wright enjoyed playing with them as children. Paper airplanes, which are essentially flying toy versions of delta-winged airplanes, existed by or before the first decade of the twentieth century.

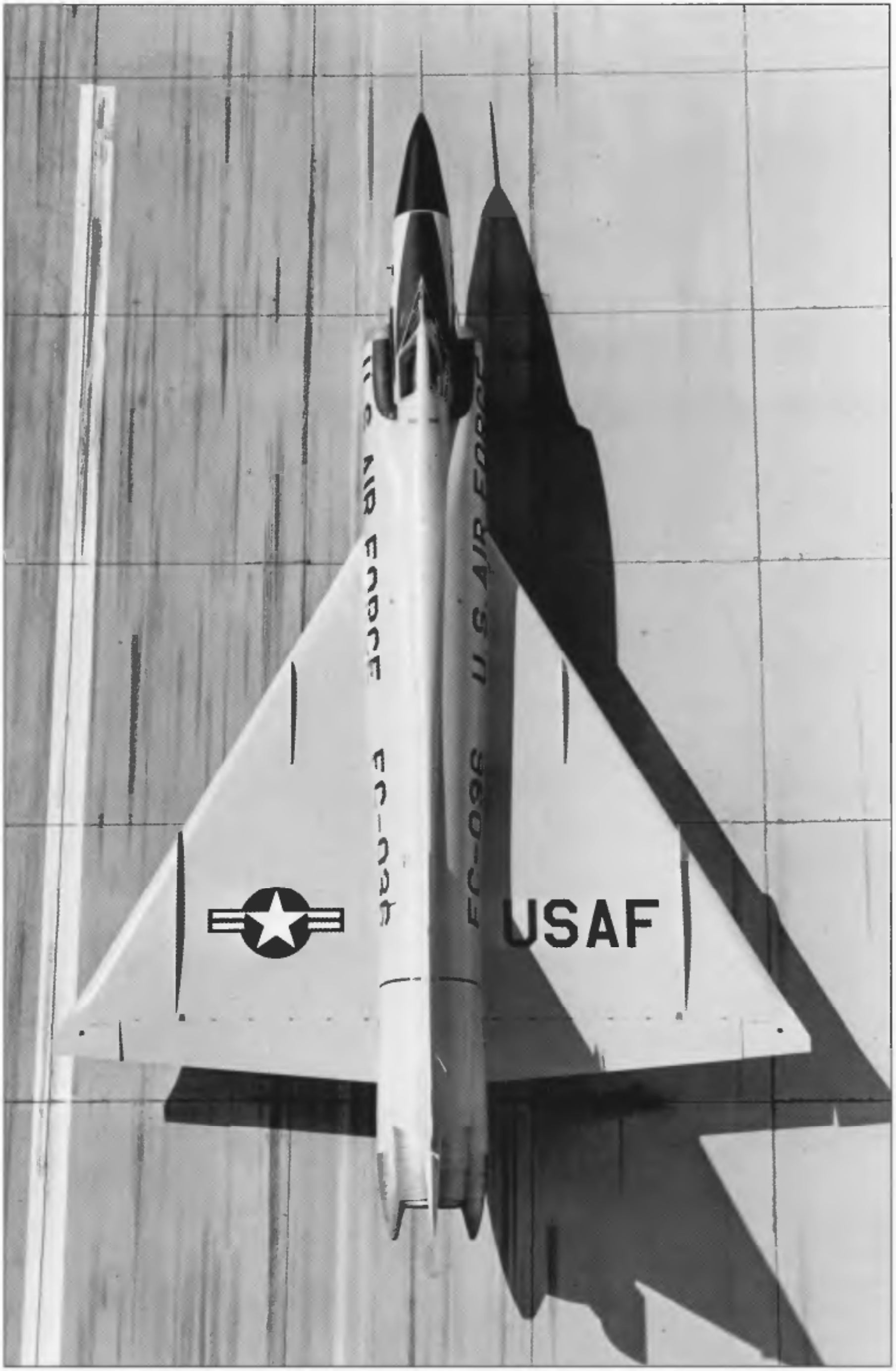
In the beginning, designers of human-carrying gliders and powered aircraft had a clean slate. There was nothing to say how wings should be shaped, or how many there should be. The Wright Brothers succeeded with a straight-winged biplane, but the first generation of aircraft also included monoplanes and triplanes. Horatio Phillips built a series of "multiplanes" that had up to three-dozen wings arranged like a Venetian blind. Most early airplane wings were straight, but in England, Mortimer and Vaughan's "Safety Biplane" had circular wings. There were even a few airplanes built with swept wings. Gradually, the blank slate was filled with straight-winged biplanes, and later with

straight-winged monoplanes, and the idea that airplanes looked a certain way became fixed.

However, there was still a corner of the slate where designers refused to conform to the paradigm. The conventional wisdom in the 1920s was that airplanes consisted of wings attached to a fuselage, with tail surfaces at the rear, but some designers questioned the need for the fuselage, and others questioned whether the horizontal tail surfaces were necessary. Had the Wright Brothers' airplanes had a fuselage? Not really.

By the 1920s, even as the standard in airplanes had become the straight-winged biplane with a fuselage and tail, some of the more innovative of designers were eliminating the fuselage and horizontal tail surfaces, placing the pilot within the wing and creating aircraft that were virtually all wing. In Germany, Hugo Junkers patented a flying-wing design in 1910, and began building a big aircraft of that design in 1919. Because the Treaty of Versailles that ended World War I prohibited large aircraft development in Germany, the project was terminated in 1921 and the partially completed prototype was destroyed. His later designs became the basis for a good deal of pulp science speculation.

As it often happens, however, science fiction would soon become science fact.



This classic 1957 top view of an Area Ruled F-102A Delta Dagger says it all. When Adolph Burstein's aerodynamicists turned from swept wings to investigating a 60-degree delta wing 11 years earlier, this is where the bold delta design initiative was headed. (Convair via Author's collection)

Kids and Convair on Elm Street, USA: The boy in the red shirt is proudly showing his Delta Dagger model to the older boy with a model of a ConvairLiner, while a girl races up to share her model of the F2Y-1 SeaDart. (Convair via Author's collection)

Lindbergh Field in San Diego was the figurative birthplace of the Convair delta concept (although the first drawings were done at Downey), and the literal birthplace of the first and most Convair delta aircraft themselves. This 1958 flight-line photograph shows a number of Block 90 F-102A Delta Daggers, with a few Block One F-106A Delta Darts among them. (Convair via Author's collection)

The business end of Convair's F-102A Delta Dagger can be seen here as this Deuce launches a bevy of Hughes AIM-4D Falcon radar-homing air-to-air missiles. Convair's first supersonic airplane, the F-102A was an outgrowth of the subsonic YF-102, and utilized the then-revolutionary design feature of a Coke-bottle-shaped "Area Ruled" fuselage, as can be seen here. Powered by a single Pratt & Whitney J-57 turbojet with afterburner, the F-102A was capable of speeds in excess of Mach 1.2. (Convair via Author's collection)

Over land and sea, Convair placed delta wings. By 1952, the XF-92A (right) was in flight test and the U.S. Navy's XF2Y-1 (left) was soon to follow. The still-top-secret delta-wing interceptor that Convair was developing had received the F-102 designation, and the world's first family of high-performance jet aircraft was well on its way. (Author's collection)

Convair's Fort Worth facility was the birthplace of the B-58 Hustler, the first prototype of which is seen here in its original livery. It made its first flight on Armistice Day in 1956. (Convair via Author's collection)

THE FIRST DELTAS

The paper airplane was arguably the first delta-winged aircraft to fly, but it took many decades before the aerodynamic principles of that innovative toy could be scaled up to a full-size airplane. In this 1952 advertisement, Convair deliberately used a paper airplane to suggest the radical shape of its first delta-winged jet, the XF-92A. Note the explanation of "Convair" as an acronym for Consolidated Vultee Aircraft at the bottom. (Author's collection)

One of the first designers to create an operable *powered* flying wing design was also one of the first to design a delta-winged aircraft. According to V. B. Shavrov in his *History of Aircraft Design in the USSR*, Boris Ivanovich Cheranovsky's BICh-3 was the first such aircraft. Powered by an 18-horsepower Blackburn Tomtit radial engine, it first flew in 1925. Based on Cheranovsky's earlier BICh-2 glider, it had no horizontal tail surfaces and a 31-foot wing whose top view looked at first glance like a half circle.

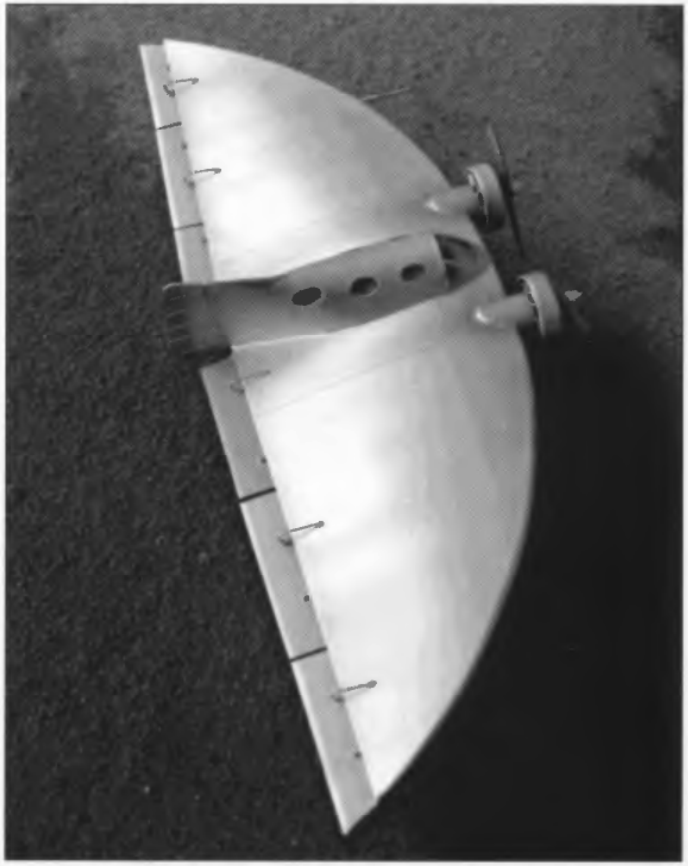
Cheranovsky's BICh-11, his first delta flying wing, originally took to the air as a glider in 1933. In glider competitions that year, it was test piloted by none other than Sergei Pavlovich Korolyov, who, after World War II, became a leading figure in intercontinental ballistic missile (ICBM) development as well as in the Soviet space program. Having had a leading role in the first Soviet manned space flights, Korolyov was heading the Soviet manned lunar-landing project at the time of his death in 1966. As for the BICh-11, it was flown experimentally with a piston engine, and there were plans to power it with a rocket engine.

By the 1930s, however, there were numerous designers working on flying-wing projects. Most notable of these was John Knudsen "Jack" Northrop in the United States, whose company would later design and build the largest and most widely operated true flying wings ever.

The wide and far-reaching aeronautical experiments and aircraft designs in Germany during the 1940s have been widely covered in many books, magazine articles, and Internet sites. These aircraft included both flying wings and delta-wings. The chief exponents of the flying-wing design in Germany during this period were Walter and Reimar Horten, while the leading figure in the development of delta-winged aircraft was Alexander Lippisch.

Born in 1894, Lippisch served as an aerial photographer during World War I and turned to aircraft design after the war. By the early 1920s, he was designing flying-wing aircraft with swept wings. His work preceded that of Cheranovsky, but because of the restrictions placed on Germany by the Treaty of Versailles, Lippisch's early aircraft were unpowered gliders. Nevertheless, like Cheranovsky, he was able to experiment with the design of practical aircraft that had no horizontal tail surfaces and virtually no fuselage. In German, the word for such aircraft is *nurflügel*.

Having built both straight-winged and swept-winged gliders, Lippisch gradually gravitated to using a delta wing. One of the driving factors behind large flying wings—as seen in both Hugo Junkers's designs and in the pulp science fantasies—was the idea that the interior of the wing could be used to accommodate large quantities of cargo. Lippisch studied this issue and came up with the idea that the leading edge of the wing should be swept and the trailing edge, straight. With this in mind, he undertook a series of *nurflügel* designs that would bear the name "Delta." Coincidentally, Jack Northrop designed and built a straight-winged monoplane during the 1930s, which he also named "Delta."



In post–World War I Russia, Boris Ivanovich Cheranovsky designed a series of aircraft with no horizontal tail surfaces and wings whose top view looked, at first glance, like a half circle. Seen here, his BICh-17 was designed in 1936, but never flown. It was proposed as a fighter, and had a wingspan of just over 40 feet. (Author's collection)

In 1928, Lippisch had experimented with placing rocket engines in his gliders, but the Delta I would be his first aircraft powered with a piston engine. The Delta I was first tested as a glider in 1930, and later equipped with a 30-hp Bristol Cherub engine. It made its first powered flight in Berlin on 25 September 1931. The aerodynamically successful Delta I was followed by a series of other designs that didn't work out, and Lippisch turned to somewhat more conventional tailless, swept-wing aircraft.

Working with the German Air Ministry (Reich Luftfarhtministerium, RLM), Lippisch designed the experimental piston-engined DFS 39 and DFS 40 in the late 1940s. Lippisch later adapted this general design for the rocket-propelled fighter program that the RLM undertook with the code name Projekt X. Under this program, Lippisch created the rocket-propelled interceptor that was manufactured for the Luftwaffe by Messerschmitt as the Me 163 Komet—probably the first aircraft ever to exceed a speed of 1,000 kilometers per hour (620 mph). Despite the limitations of an extremely short combat radius, the Komet was fast and virtually unstoppable to Allied countermeasures.

Having designed the Komet rocket plane, Lippisch designed a number of turbojet-powered variants that were never flown, and he also returned to the idea of a pure delta-winged aircraft. His P12 high-speed jet interceptor, designed in 1943 but never actually flown, was a delta flying wing, with the fuselage smoothly blended into the wing in the manner of much later aircraft, such as the F-16. In turn, the Lippisch P13a interceptor located the cockpit in the root of the vertical tail and completely buried the engine in the delta wing. The P12 was never built, but the RLM ordered wind-tunnel models and a mock-up of the P13a in 1944. A full-scale test glider was also ordered under the designation DM-1.

The Lippisch DM-1 glider, the aircraft that was to be the direct predecessor to the postwar Convair deltas was only 22 feet long, with a 19.4-foot wingspan. The power for this extremely futuristic aircraft would have been a decidedly low-tech, coal-burning ramjet, boosted by rocket engines. A load of 1,760 pounds of coal was calculated to give the aircraft 45 minutes of flight time. The use of coal to power the aircraft was dictated by the scarcity of oil in the Third Reich by 1944. Revisionists, who have claimed that the Allied strategic bombing offensive had little effect on the German economy, should take note of the German aircraft industry resorting to using coal to power jet interceptors!

Of course, the DM-1 prototype had no engine, given that it was built as a glider to test the aerodynamics of the overall design. The operational P13a was intended to be built of metal, but the DM-1 was built mainly of wood. The plan was for it to be carried aloft by a Siebel Si 204 utility aircraft and released at high altitude for its glide tests and an unpowered landing. Operational powered P13a aircraft would follow.

After successful testing of the wind-tunnel model in Vienna, construction of the full-size DM-1 got underway in early 1945 at the town of Prien am Chiemsee, near the city of Rosenheim in Bavaria. On 3 May, however, the U.S. Army swept through Bavaria and Prien was captured.

By this time, it was well known to Allied intelligence services that the Germans had numerous ongoing highly advanced scientific projects. This was especially true of a host of remarkable aircraft—including, but not limited to, the Komet and the Messerschmitt Me 262 jet fighter—that German industry was developing for the Luftwaffe. With this in mind, efforts were initiated to locate and capture technical data, hardware, and scientists that would be useful

This model suggests the hypothetical appearance of Alexander Lippisch's P13a delta-winged interceptor as it might have appeared in Luftwaffe markings. (Courtesy of Allen B. Ury, Fantastic Plastic Models)

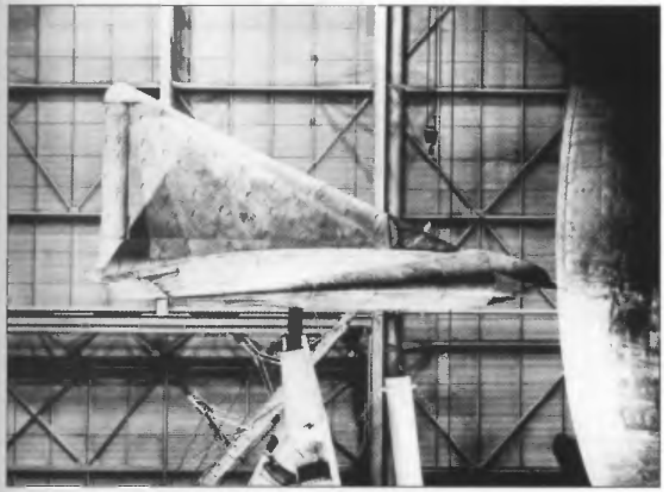
in postwar Allied projects. The best known of these was *Operation Paperclip* (originally *Operation Overcast*), which was organized by the United States Joint Chiefs of Staff. The first priority of this project was to round up data and personnel related to Germany's nuclear and ballistic missile programs. With nuclear weapons, the Germans were found to lag behind the United States, but with guided missiles, it was another matter. Thanks to German rocket scientists, such as Wernher von Braun and others, the United States was able to jumpstart the development of numerous systems, from ICBMs to the Saturn V vehicle that took Americans to the moon a quarter century after World War II.

The U.S. Army Air Forces (USAAF), meanwhile, had its own postwar program aimed specifically at gathering intelligence related to German advanced aeronautical projects. Begun in April 1945, as Allied armies swarmed into Germany, this activity was codenamed Operation Lusty, an acronym of Luftwaffe Secret Technology. The personnel for this operation were USAAF Air Technical Intelligence teams, who were trained at the Air Materiel Command's Technical Intelligence School at Wright Field in Ohio. They drove their jeeps across the border into Germany, accompanying the combat troops as they battled the crumbling German armies. The Air Technical Intelligence teams captured German jets, coaxed German pilots to work for the USAAF, and gathered truckloads of documents. They also captured the unfinished DM-1 at Prien.

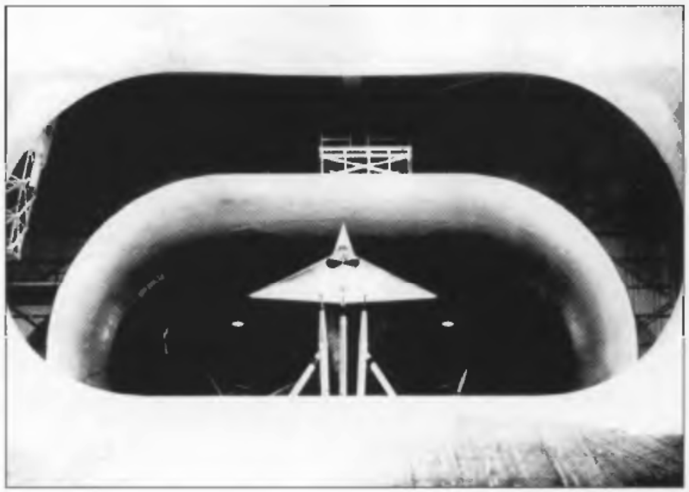
Aerodynamicist Theodore von Kármán of the California Institute of Technology, a consultant to the Materiel Command and later the head of the USAAF Scientific Advisory Group (SAG), was briefed on the unfinished DM-1. When he realized what it was, he insisted that it be completed and tested. A C-47 was provided for flight tests in Germany, but the USAAF decided instead to ship the DM-1 to the United States. It arrived in Boston in January 1946, and was sent to the huge wind tunnel at Langley Field in Virginia that was operated by the National Advisory Committee on Aeronautics (NACA), the predecessor of the National Aeronautics and Space Administration (NASA).

Meanwhile, Alexander Lippisch was also brought to the United States, where he worked as a consultant to the Air Materiel Command at Wright Field. Though his name does not appear on any official NACA documentation, he reportedly served as a consultant on the DM-1 tests at Langley. In 1950, he began a 14-year career with the aircraft division of the Collins Radio Company in Cedar Rapids, Iowa, where he passed away in 1976.

Though extensively ground tested, the DM-1 was apparently never flown. Heavily modified during its NACA career, the DM-1 still exists in the collection of the Smithsonian National Air and Space Museum. The NACA testing data also found a home. While German swept-wing technical data had many companies taking an interest, delta-wing data caught the eye of the Consolidated Vultee Aircraft Corporation in San Diego. In the postwar environment, every major U.S. aircraft manufacturer was eager to exploit new technologies and develop new aircraft that embodied them. Nearly every aircraft company had a jet bomber and a jet fighter on the drawing boards as World War II came to a close. At Consolidated Vultee, its jet fighter would eventually incorporate delta wings.



The Lippisch DM-1 prototype arrived at the National Advisory Committee on Aeronautics wind tunnel at Langley Field in Virginia in 1946. Although never actually flown, the design provided much useful data for U.S. aeronautical engineers and was modified extensively throughout its NACA ground studies. (NASA Langley Research Center via Author's collection)



A front view of the Lippisch DM-1 in the National Advisory Committee on Aeronautics wind tunnel at Langley Field. Some considered its otherworldly appearance unorthodox, but it inspired Convair's engineers to turn over a new leaf of velum on the drawing boards at Downey. (NASA Langley Research Center via Author's collection)

Chapter Two

What Was Convair?

During World War II, Consolidated Vultee produced 6,729 aircraft in San Diego, mainly the big four-engine B-24 Liberator. Consolidated rolled out the first B-24D in January 1942. Seen here are Block One B-24Ds on an assembly line that would later host ConvairLiners and Convair deltas. (Author's collection)

The word Convair was long used as a shorthand rendering of the corporate name Consolidated Vultee Aircraft Corporation, even before Convair actually came into being as a legal entity in 1954. Consolidated Vultee, as the name suggests, was formed as the merger of two companies, Consolidated Aircraft (known informally as "Consair") and Vultee Aircraft. This is an amalgamation that took place in 1943. The former company was the creation of industrialist Reuben Hollis Fleet, the latter the creation of the brilliant designer Jerry Vultee. The two future "partners" would never meet, but their companies would come together as the breeding ground for delta-winged birds that neither could have imagined in those days before the merger.

Whenever I speak of the origins of Convair, there is always a motivation to quote corporate historian Howard Welty, who wrote in 1961, "Like a great river, Convair derives from many sources. The main stream begins with Consolidated in 1923. Some of the tributaries reach farther back."

The first of the tributaries in Welty's metaphor is the Gallaudet Engineering Company, formed in 1908 in Norwich, Connecticut, by 31-year-old Edson Gallaudet. Reuben Fleet was its general manager in the years immediately after World War I, when a general slump in the American aircraft industry caused Gallaudet's board of directors to take drastic measures. Fleet suggested liquidation, and said he'd form his own company to fulfill the Gallaudet contracts, paying the Gallaudet directors 10 percent of his own net worth to rent the former Gallaudet plant. They agreed, and Fleet formed his Consolidated Aircraft Corporation in 1923.

As the name of his company implies, Fleet's corporate plan was to form an aircraft company that "consolidated" numerous entities under a single corporate roof. He began with Gallaudet and added a portfolio of designs that he purchased from General Motors when it closed the Dayton-Wright subsidiary. This entity took its name from having had Orville Wright (of Dayton, Ohio) as a consultant. In 1929, Fleet integrated yet another important component into Consolidated with the purchase of the Thomas-Morse Airplane Company of Ithaca, New York. This firm traced its lineage to the company founded by William and Oliver Thomas in 1910, and had produced some of the Army's best single-engine aircraft in the post–World War I years, such as the S-4 Scout and the MB-3 Hawk.

In September 1924, Fleet moved his company from the old Gallaudet plant in Connecticut to new facilities in Buffalo, New York, near where the huge Curtiss-Wright firm had its factories. Unlike Dayton-Wright, Curtiss-Wright did trace its roots back to one of the companies actually founded by the Wright Brothers, Wright Aeronautical. In large part because of the presence of Curtiss-Wright, there was a surplus of skilled labor in the area that had been drawn to the factories of this Great Lakes port city during World War I. Because of this, Buffalo had become an early center of aeronautical activity in the United States.

Though at first blush, Consolidated had the appearance of a paper holding company, Fleet actually used it to develop new aircraft that made it greater than the sum of its consolidated parts. His first was a Dayton-Wright design, the TW-3 primary trainer, which the U.S. Army purchased and designated as the PT-1, and named Husky. Within a year of the move to Buffalo, Consolidated added the U.S. Navy to its customer base with orders for a naval version of the Husky.

Fleet's next big step in expanding the Consolidated product was to move into the development of large, twin-engine flying boats, mainly for the Navy. Fleet and his general manager, Isaac Machlin "Mac" Laddon, developed the XPY-1 Admiral, which was billed as "the largest flying boat built in the United States" in 1928. The fact that Buffalo fronted Lake Erie made flight testing a theoretical breeze, but the Admiral was completed in the winter, Lake Erie was frozen, and the aircraft had to be crated and trucked to the Navy test center at Anacostia, D.C., on the unfrozen Potomac.

In the Navy's flying boat evaluation, the Admiral came in second behind the less expensive

Reuben Hollis Fleet, the "Great Consolidator," whose vision and business acumen built the Consolidated Aircraft Company on the foundation of the Gallaudet Engineering Company plus the Dayton-Wright subsidiary of General Motors. (Author's collection)

Gerard Frebairn "Jerry" Vultee, the "boy wonder" of American aviation surfed with Duke Kahanamoku, studied engineering at Caltech with Robert Millikan, and designed airplanes with both Jack Northrop and Charles Lindbergh. (Author's collection)

XP3M-1 built by the Glenn L. Martin Company. Though the military contract eluded his grasp, Fleet did as any enterprising aviation entrepreneur might be expected to do, he invested in an airline and introduced a civilian version of the Admiral. In April 1929, he teamed up with James H. Rand of Remington Rand, the typewriter and business machine conglomerate, to invest in an airline called New York, Rio & Buenos Aires Line (NYRBA) that was actually the idea of Capt. Ralph O'Neill. A former Army pilot, O'Neill had been an advisor to the Mexican air corps, and he had conducted a fact-finding junket to South America. Though Pan American Airways had established itself as the major airline in the region, O'Neill thought NYRBA could be competitive, and he managed to line up airmail contracts with the Argentine and Brazilian governments. The venture was short-lived, being bought by Pan Am in August 1930, but NYRBA did serve to launch the successful commercial version of the XPY-1, which was known as the Commodore.

Consolidated's development of the commercial Commodore gave the company another opportunity to present an aircraft design to the U.S. Navy. Fleet and Laddon redesigned the Commodore, creating what was called a "sesquiplane" variant. Neither a biplane nor a monoplane, the sesquiplane had abbreviated lower wings, each mounted with pontoons. The Navy approved the design and placed an order that would lead to 47 of the new planes being delivered, beginning in 1933, under the designation P2Y, and known as the Ranger.

Reuben Fleet's next move with Consolidated was to move the company again. After a decade in Buffalo, he looked west. He was now focusing on flying boats, but with Lake Erie frozen for part of the year, he couldn't flight-test them. He looked at a map and decided to pick a body of water that had never frozen and never would—San Diego Bay. In 1935, Fleet left the bitter winters of Buffalo for sunny San Diego. As with the move to Buffalo, Fleet went to a city that already had a bit of aviation history. T. Claude Ryan had built the Ryan NYP, better known as Charles Lindbergh's *Spirit of St. Louis*, in San Diego. Indeed, the airport where Fleet put down roots was then—and still is—known as Lindbergh Field. It was a perfect place for a builder of flying boats. The field, and the factory that Fleet planned, were just a stone's throw from the tide flats adjacent to San Diego Bay.

For Consolidated's operations Fleet built the company's Building 1, a 247,000-square-foot, continuous-flow factory that opened for business in September 1935. Its work force included 874 people, many who had come from Buffalo, as well as 463 who were the first of more than 100,000 San Diegans who would make Consolidated the city's largest civilian employer for the next half century.

If Fleet's role at Consolidated was to think up the big ideas—like moving a company across a continent—the airplane ideas were within the sphere of Mac Laddon. The first product to take wing in San Diego had earlier taken shape on the Buffalo drawing boards. This was the large, twin-engine flying boat they called the Catalina, the aircraft that would be the second-biggest-selling product in company history. The prototype for the aircraft first flew in 1935 and it was ordered by the Navy under the patrol designation XP3Y-1. However, the Catalina would enter service as the PBY, for "Patrol Bomber, Consolidated." The first production PBY was launched in San Diego Bay in October 1936.

The Consolidated Aircraft Company plant in Buffalo, New York, as it appeared in June 1926. Reuben Fleet had moved the company here from Norwich, Connecticut, in September 1924 to take advantage of a large pool of skilled labor in this Lake Erie port city. (Author's collection)

As the Catalina was taking wing, Fleet and Laddon dreamed bigger dreams, and these featured a larger, four-engined flying boat. The Catalina was named for an offshore California island that was a popular tourist destination. The new flying boat would be named for the island in San Diego Bay where the U.S. Navy had a huge San Diego base—Coronado. It would have a gross weight of 66,000 pounds, more than double that of the Catalina. The proposal won a Navy design competition in late 1935 for a four-engine patrol bomber, and the Coronado was ordered into production under the designation PB2Y. The first XPB2Y-1 test aircraft made its first flight in 1937.

As orders for Catalinas and Coronados came in, Consolidated enlarged the San Diego factory, boosting the production area to 543,000 square feet, including an enclosed, paved yard where overflow final assembly operations could be conducted outdoors in the warm sunshine. What a far cry from Buffalo.

Having reached California and having sketched a picture of Consolidated, it is now time to take a look at Vultee. As I have often said, Gerard Frebairn "Jerry" Vultee was one of the "boy wonders" who made early American aviation so interesting. Born in Brooklyn, New York, in 1900, he grew up in Ocean Park, California. He surfed with Duke Kahanamoku, and he studied engineering at the California Institute of Technology with Nobel laureate Dr. Robert Millikan.

At a time when Southern California was rapidly becoming the epicenter of the growing American aircraft industry, Vultee more than just crossed paths with the greats who have since become the household words of aviation history. He met Jack Northrop while working for Donald Douglas, and he moved with Northrop to Lockheed in 1927, where he played an important role in Lockheed's Vega and Air Express. Here, he also worked with the brilliant Clarence Leonard "Kelly" Johnson, who later founded Lockheed's legendary Skunk Works. In June 1928, when Jack Northrop resigned as Lockheed's chief engineer to pursue his own projects, Vultee took his place. In this role he worked with Charles Lindbergh to design the Sirius low-wing monoplane. He also created the airplane that Wiley Post used to set, and then break, the speed record for a round-the-world flight.

Against the backdrop of his short but full career, it was only natural that an ambitious young man like Jerry Vultee would decide to go into business for himself. By 1931 Vultee had designed his new V-1 all-metal monoplane, and had interested American Airlines in buying it. He just needed money to build it. In 1932, he teamed up with Vance Breese to form the Airplane Development Corporation, and went looking for capital. At this point, boy wonder Vultee met Errett Lobban Cord, the fast-moving "boy wonder of Wall Street," who owned or controlled the Cord, Duesenberg, and Auburn automobile companies as well as Century Airlines, Lycoming Motors, American Airlines, and Stinson Aircraft. The latter, which had been started by Eddie Stinson in 1926, was responsible for the legendary Detroiter series of early airliners. Eddie Stinson died in a crash in 1932.

Cord supplied the backing for Vultee's venture in exchange for controlling interest. In 1934 he created the Aviation Company (Avco) as an umbrella for his holdings, and Vultee was named vice president and chief engineer. Within three years, Vultee was heading his own factory, the Vultee Aircraft Division, in Downey, California, with more than a million dollars in orders for V-1s, V-1As, and V-11s.

Everything was going right for Jerry Vultee. In January 1935, he married Sylvia Parker, the daughter of Twentieth Century Fox director Max Parker. On their honeymoon trip to Mexico City, Vultee set a speed record in his V-1A. Three years later, the Army Air Corps was interested in a military derivative of his V-11, so he and Sylvia flew to Washington, D.C., in Jerry's Stinson Reliant to make the sales pitch. In January 1938, on the way back to California, they took off from Winslow, Arizona, into a snowstorm. Less than an hour later, the Reliant crashed into Mount Wilson near Flagstaff. Jerry and Sylvia were dead, and their infant son Peter was an orphan. Like Eddie Stinson, Jerry Vultee died young and well before his full potential could be realized.

Vultee's sales pitch, however, had worked. The Air Corps bought the V-11 under the designation YA-19, and Avco hired Dick Palmer away from Howard Hughes to take Jerry's place. Building on the same basic low-wing monoplane design of the V-11, Dick Palmer had created the Vultee Valiant training aircraft, which was sold to the U.S. Army as the BT-13 and BT-15, and to the Navy as the SNV. The Avco Vultee division became the separate Vultee Aircraft Corporation in 1939.

By 1939, the clouds of war were gathering in Europe, and on 1 September, Hitler sent the German armies into Poland. Britain and France responded with declarations of war, and World War II had begun. The need for military aircraft now took on a whole new meaning. Though the United States would not enter the conflict for two long years, American industry would be gearing up to supply weapons and aircraft not only to American services, but to foreign air forces as well. Britain and France sent delegations on shopping trips to survey American aircraft manufacturers.

By the spring of 1940, the German Blitzkrieg had swallowed Norway, Denmark, Belgium, and the Netherlands, and German

When the U.S. Navy didn't show much interest in the XPY-1 Admiral flying boat, Reuben Fleet and Mac Laddon transformed the aircraft into the Commodore airliner, which became the backbone of NYRBA, the New York, Rio & Buenos Aires Line. (Author's collection)

armies swarmed into France. Though the American people wanted to stay out of and as far away as possible from "Europe's War," there was a growing realization that this might not be possible. On 16 May 1940, two days after the Dutch government fled in disarray, Hitler's fast-moving blitzkrieg was on the move and France was teetering on the brink of collapse. This was the same day that President Franklin Delano Roosevelt went before Congress to propose that Congress authorize funding for 50,000 military aircraft. In July, Army and Navy planners studied the practical side of arriving at Roosevelt's 50,000, deciding on a 73-27 split. Of its 36,500-unit allocation, the Army Air Corps had around 7,700 undelivered aircraft from 1939 and 1940 orders, so 28,000 units became the official target number, and April 1942 became the target date. With this came a government mandate to the manufacturers to expand their capacity and build new factories to handle larger numbers of orders.

The increased orders and mandated expansions affected both Consolidated and Vultee. The latter's signature product line was small, single-engine aircraft, while down the coast in San Diego, Consolidated was building larger, four-engine aircraft, including the PB2Y Coronado for the U.S. Navy and the B-24 Liberator heavy bomber for the Army Air Corps. The XB-24 prototype made its debut flight in December 1939, and the first production-series aircraft were ordered in 1940—by the French in June and the U.S. Army Air Corps in August. France was defeated by the Germans within days of placing their orders, so these export Liberators, designated as LB-30, went to Britain.

Reuben Fleet should have been pleased by the increased orders for PBYs and B-24s, but the government-mandated plant expansions sucked up company resources. Manufacturers were to be reimbursed for the costs of gearing up to build unprecedented numbers of planes, but the money was slow in coming. In the fall of 1940, Fleet was invited to a summit conference of leading aircraft manufacturers called by the head of Roosevelt's National Defense Advisory Commission, William Signius "Big Bill" Knudsen. He was an expert on mass production who had been an executive at the Ford Motor Company and had served as president of General Motors since 1937. Knudsen wanted to discuss the automobile industry's role in aviation if the United States entered the war, but Fleet wanted to discuss promised reimbursement for the first round of the Consolidated's plant expansions. The company had completed construction and submitted its invoice for $2.47 million of expenditures (approximately $34 million in current dollars) eight months before, but no repayment had come through from the Treasury Department. An embarrassed Undersecretary of the Navy James Forrestal promised to cut a check the same day, but Fleet was growing increasingly annoyed by what he saw as "meddling" from government defense mobilization agencies and the "near-confiscatory" tax burden that he carried as chairman, president, and general stockholder.

Less than a year later, in the summer of 1941, Fleet decided to step down from the leadership of the company that he had created, and retire at the relatively young age of 54. In August, he began negotiations with Victor Emanuel, now the president of Avco, which would lead to a sale of his 34.26 percent share in Consolidated. The idea was that Consolidated would be merged with Avco's Vultee subsidiary. The papers were signed on 28 November 1941—less than two weeks before Pearl Harbor—and Fleet parted with his controlling interest in Consolidated for $10.9 million (approximately $151 million in current dollars). In March 1943, all of the stockholders had given their final approval, and the Consolidated Vultee Aircraft Corporation had officially come into being.

During World War II, Consolidated Vultee produced 30,930 aircraft, placing it just 500 units behind Douglas and third place in the

In 1935, Reuben Fleet pulled up stakes to move Consolidated from freezing Buffalo to balmy San Diego. This was the entrance to the main corporate offices as they appeared in February 1936. The old offices were blanketed by snow that day. (Author's collection)

Originally ordered by the U.S. Navy under the patrol designation XP3Y-1, the Consolidated Catalina was a large, twin-engine flying boat that entered service as the PBY patrol bomber. The prototype first took off from San Diego Bay in 1935. (Author's collection)

entire U.S. aircraft industry. North American Aviation was first with 41,839 aircraft. The Vultee plant at Downey, California, led the way among the company's factories, building 11,687 aircraft, mainly BT-13 and BT-15 Valiant trainers. Vultee also built 1,966 aircraft at its expansion facility in Nashville, Tennessee. Most of these were A-35 Vengeance attack bombers. As a relic of a 1940 acquisition made by Avco, Vultee's previous parent company, Vultee also operated the former Stinson factory in Wayne, Michigan. Here, 4,104 aircraft were built during World War II, mainly L-5 Sentinel light utility airplanes.

The Consolidated headquarters plant at San Diego produced 6,729 units according to USAAF records, mainly large, four-engine B-24 Liberator heavy bombers. Consolidated also built 221 Navy patrol bombers in New Orleans, and it operated the vast USAAF Plant 4 factory north of Fort Worth. Built expressly for B-24 production, Fort Worth delivered 2,743 of them by war's end, along with 291 of the C-87 Liberator Express, the transport version of the big aircraft. Another product of the Fort Worth plant was the B-32 Dominator, a sort of "Super Liberator" that was ordered by the USAAF as a companion to the Boeing B-29. Originally known as the Terminator, the first prototype XB-32 made its initial flight in 1942, and the first production B-32s were delivered late in 1944. Consolidated built 114 Dominators before the war ended, and a few saw service in the Pacific, but the USAAF decided to concentrate production on the B-29, and the program was canceled in September 1945.

Both the San Diego and Fort Worth factories would play important roles in the postwar development of the delta jets.

Because Consolidated Aircraft Corporation had long been known by insiders and the people of San Diego as "Consair," it was natural that the term "Convair" as a contraction for Consolidated Vultee Aircraft Corporation would be adopted almost immediately.

The production series PBY Catalinas started rolling off the Consolidated line in October 1936. In terms of numbers, it would be the company's second-biggest-selling-product ever—after the B-24 Liberator. (Author's collection)

Isaac Machlin "Mac" Laddon (left), Consolidated's Chief Engineer, with Maj. Gen. Henry Harley "Hap" Arnold, Chief of the U.S. Army Air Corps during the latter's visit to the Consolidated plant in San Diego on 10 December 1939. (Author's collection)

However, it would not become an official corporate name until after World War II. The abbreviation was seen during the war as "ConVAir," "ConVair," "Convair," or written with the letters CVAC. The latter became standard by the end of the war, but it was still unofficial. Consolidated Vultee remained the formal company name. In 1954, the entity officially became the Convair Division of General Dynamics Corporation.

Like Convair, General Dynamics was, to paraphrase Howard Welty, derived from many sources, though its main tributary was the Electric Boat Company. Founded in 1899 by immigrant Irish schoolteacher John Holland, the company went on to build submarines for the U.S. Navy in both World Wars. Just as Reuben Fleet was the principal consolidator in the early days of his company, John Jay Hopkins was the consolidator who created General Dynamics. A lawyer and financier, Hopkins became president of Electric Boat in 1947, and set out to build it into a diversified and well-rounded defense contractor. Hopkins also bought Canada's leading airplane manufacturer, Canadair, in 1947. In 1952, he created General Dynamics Corporation as an umbrella organization for the new integrated company that he envisioned. Next, Hopkins, whose motto was "grow or die," purchased a controlling interest in Consolidated Vultee from the Atlas Corporation, which had owned a majority of Consolidated Vultee stock since November 1947.

On 3 March 1954, the directors of New York-based General Dynamics and San Diego-based Consolidated Vultee signed off on a merger that was approved by stockholders six weeks later. Of the 63,000 workers who now took home a General Dynamics paycheck, 45,000 worked for the Convair component in California and Texas. Another 11,000 worked for Canadair in Montreal, while 6,900

worked for Electric Boat in Groton, Connecticut, and its Electro Dynamic Division in Bayonne, New Jersey. Among the most important technological innovations made by General Dynamics during the 1950s was the development, in partnership with the U.S. Navy, of nuclear-powered submarines.

In a March 1954 memo to Convair employees, Hopkins wrote, "As a united group, General Dynamics and Convair will represent one of the strongest arms of the free world's defense effort. We are groups which are moving swiftly in the fields of hydro-dynamics, aerodynamics and nuclear dynamics, and as such might appropriately be called, as a corporate unit, 'Dynamics for Defense.' The union of Convair with General Dynamics will result in a tremendously improved position. Convair will have a far broader credit base for greater operations, and together with our other aircraft facilities will present a production capacity greater than any other aircraft group in the world."

At the time of the merger, Convair's San Diego Plants 1 and 2 (the latter being leased from the U.S. Air Force) comprised 4,595,000 square feet of factory space, while Convair's Fort Worth plant, an Air Force-owned facility in which B-36 bomber (and later B-58) production centered, had factory space totaling 4,367,000 square feet.

In 1951 Convair had formed a division to produce the Terrier missile for the Navy and, two years later, this group moved to a new plant in Pomona, California. Convair-Astronautics became a separate operating element for production of the Air Force Atlas intercontinental ballistic missile (ICBN) in 1957 and, four years later, it achieved full division status as General Dynamics Astronautics. After 1961, the newly created Pomona Division operated the Naval Industrial Reserve Ordnance Plant for the Navy Bureau of Ordnance, a facility with 1,466,000 square feet of factory space where several successful Navy weapons systems were produced.

Over the subsequent years, General Dynamics grew as John Jay Hopkins had envisioned. General Dynamics acquired Stromberg-Carlson Telephone in 1955, which went on to develop the world's first solid-state electronic switchboard in 1956. In 1961, out of the Stromberg-Carlson subsidiary, General Dynamics formed its Electronics Division, which was moved from Rochester, New York, to San Diego in 1972. Another important spin-off from this lineage was the pioneering computer and microfilm subsidiary, DataGraphix, which was created in 1976. Convair itself expanded, building a new factory at Kearny Mesa on the north side of San Diego to build the Atlas ICBM—and, later, Atlas space launch vehicles.

John Jay Hopkins died of cancer on 7 May 1957, while still in the process of building General Dynamics. Frank Pace, recent secretary of the Army, was hired to replace him. John Jay Hopkins Drive in La Jolla, California, is named after him.

In 1971, David Sloan Lewis became chairman and chief executive officer of General Dynamics. The former president of McDonnell Aircraft, Lewis had been responsible for the creation of the F-4 Phantom and had overseen the development of the Mercury and Gemini spacecraft. During his 14-year tenure, the revenues and earnings of General Dynamics quadrupled, and the company developed the F-16 Fighting Falcon.

General Dynamics created its General Atomic division in 1955, and sold it to Gulf Oil in 1967. Canadair was sold to the Canadian government in 1976, but General Dynamics made a number of major acquisitions including the purchase of Chrysler Corporation's Defense Division in 1982 and Cessna Aircraft in 1985. The acquisition of Chrysler's Defense Division allowed General Dynamics to turn around the tank business at a time when the M1 Abrams main battle tank was in development. John DeBlanc, a vice president of program development at General Dynamics, told me in a 1994 interview that the Chrysler acquisition was "good for the Army and the taxpayer."

During the 1990s, General Dynamics acquired numerous businesses, including Lockheed Martin Defense Systems, Lockheed Martin Armament Systems, National Steel and Shipbuilding Company, and Gulfstream Aerospace. Meanwhile, however, tributaries were flowing out of the great river of General Dynamics. In 1992,

When World War II began in Europe, Consolidated undertook a massive plant expansion at its San Diego facility. This is the new addition to the Engineering (a.k.a. Experimental) Building as it stood on 19 March 1940. By the end of the decade, Consolidated's factory complex had stretched to nearly a mile in length alongside what is now a main freeway artery. (Author's collection)

This view looking southwest shows the Consolidated Engineering (aka Experimental) Building as construction proceeded on May Day in 1940, as German armies were poised to swallow Western Europe. The windows were in, and engineers were at work on the coming generations of aircraft. Design work on the Convair deltas occurred here. (Author's collection)

the conglomerate sold Cessna to Textron and its Tactical Missiles Division to Hughes Aircraft Company. The following year, General Dynamics' fixed-wing military aircraft operations, specifically the F-16 factory at Fort Worth (earlier part of the Convair Division), was sold to Lockheed. The Space Systems Division, makers of the Atlas facility of space launch vehicles, was sold to Martin Marietta in 1994, shortly before it merged with Lockheed.

Also in 1994, General Dynamics made the decision simply to close what remained of the Convair Division. Since 1970, the only production work at the Lindbergh Field operation in San Diego consisted of missiles and Convair-built fuselage sections for McDonnell Douglas DC-10 jetliners and KC-10 refueling aircraft. The last of 446 DC-10/KC-10 sections was delivered in May 1988. By this time, the DC-10 program had evolved into the MD-11 program and Convair designed and built the sections for this aircraft as well. For the MD-11, Convair produced 5 fuselages in 1988, 9 in 1989 and 12 in 1990. The production peak came in 1991–1992 with the annual delivery of 37 sections each year. In turn 22, 20, and 23 were delivered between 1993 and 1995, respectively.

A postwar view of the Consolidated Vultee San Diego complex looking north on Pacific Highway during the summer of 1948. The light-colored building that was formerly the main office had been superseded by a larger building across the street. In the foreground, Building 115 was the machine shop, and farther down the street, Building 110 housed tube bending. Still farther, Building 136 was home to welding and plating. Beyond Overpass 2 were the personnel offices in the low building and the wing and fuselage subassembly in the taller complex. The main product was then ConvairLiners, but soon it would be deltas. (Author's collection)

Production of these components was destined to be the last aircraft production that would take place at Convair. On 1 July 1994, Art J. Veitch, vice president and general manager of the Convair Division, told employees that in early 1996 Convair would cease to exist. Veitch went on to say that General Dynamics and McDonnell Douglas had looked at the worldwide slump in demand for jetliners and had decided to end production of the MD-11 sections by Convair with the delivery of Shipset Number 612 in early 1996.

The factories that had built tens of thousands of aircraft emblazoned with Convair eagles, and that now produced the fuselage sections for McDonnell Douglas DC-10s and MD-11s, would be demolished and the land turned back to the San Diego Port Authority, from which it had been leased for half a century.

As Barbara McDonald of Convair told me in a 1994 interview, "By the end of 1995, there will be approximately 200 people left on staff to close down the plant beginning in 1996. Convair is responsible for tearing down the factory starting at the south end of the plant with two buildings that aren't in use any more. We have to take it back to its original form when we leave."

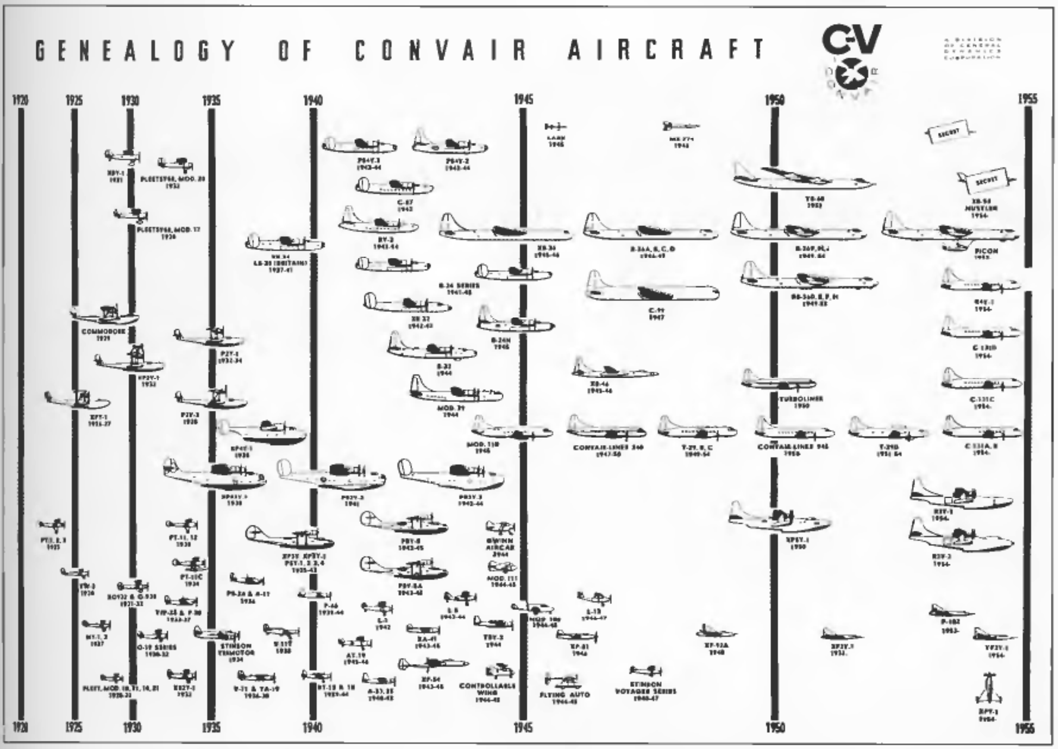
John Jay Hopkins was the former special assistant to the Secretary of the Treasury who became president of the Electric Boat Company and created General Dynamics. In 1954, he acquired a controlling interest in Consolidated Vultee and made it the Convair Division of General Dynamics. (Author's collection)

A Consolidated Block 30 B-24J-CO on a delivery flight over San Diego Bay. San Diego rolled out 2,792 B-24J-COs, Consolidated Vultee's Fort Worth plant built 1,558 B-24J-CFs, and both Ford and Douglas built the aircraft under license. (Author's collection)

A Convair design team at work in San Diego, circa the late 1940s. Most department heads were still men, but the postwar legacy of World War II's "Rosie the Riveter" had made an impact on most departments. (Author's collection)

The first of two Consolidated Vultee XP-54 fighters on the tarmac at Downey, California, circa late 1943. Early in World War II, while Consolidated focused on large aircraft, the engineers at its merger partner in Downey were beginning to develop a family of leading-edge fighters that would lead to their pushing the envelope toward the postwar deltas. (Convair via Author's collection)

The first of two Consolidated Vultee XP-81 long-range high-performance fighter prototypes in flight over the California desert. First flown in February 1945, the aircraft was powered by both turboprop and turbojet engines. The program was canceled as World War II ended, but many of the people who worked on that program went on to successful careers designing and building Convair deltas. (Convair via Author's collection)



A "genealogy" of Convair products through 1955, when both the B-58 Hustler and the F-106 Delta Dart were still considered "Secret." (Convair via Author's collection)

Chapter Three

The XF-92 Program

Although of poor quality, here is an early photo of the XF-92A on the lakebed at Edwards AFB, in its pre-1951 natural-metal finish. (Convair via Author's collection)

Consolidated Vultee had ended World War II with the biggest item in its order books being the huge B-36 Peacemaker intercontinental bomber, the largest such aircraft ever built. As I have often pointed out, the B-36 was the largest and last great bomber of World War II. Though it did not fly until 1946, a year after the war ended, it represented wartime technology and was indeed designed for a wartime mission. Though the six-piston engines, with which the B-36 was originally built, were later augmented by four turbojets ("six turning and four burning" as they used to say), the B-36 was soon overtaken by the new and rapidly advancing turbojet-era technology that swept over American aviation like a tidal wave.

Even before the war ended, Consolidated Vultee was eager to get a piece of that new technology. Major American aircraft manufacturers were quick to stay ahead of the curve and to design and propose both jet bombers and jet fighters—and this was encouraged by the USAAF, which requested the proposals. As early as November 1943, the USAAF had requested proposals for all-jet medium bombers with a range of 3,500 miles, a service ceiling of 45,000 feet, and a top speed of 550 mph. The development of such aircraft moved slowly at first, as jet engines with sufficient range evolved. The Consolidated Vultee proposal for a jet bomber was its fairly conventional, straight-winged Model 109. The USAAF (U.S. Air Force after 1947) ordered three under the designation XB-46, but only one was built. Boeing submitted its swept-wing XB-47 Stratojet as a proposal for the same requirement and it won the production orders.

During World War II, Consolidated Vultee had developed a hybrid turboprop/turbojet fighter that was ordered under the designation XP-81. It first flew in February 1945, but the program was canceled after only two were built because the war ended and such a plane was no longer deemed necessary. Pure jets, not hybrids, were the future of fighter aircraft.

In August 1945, the USAAF began issuing requests for proposals for a new generation of high-technology aircraft. Among these was a long-range jet fighter capable of escorting bombers into enemy territory, and a 700-mph jet interceptor. Consolidated Vultee, like other plane makers, was already thinking about such an aircraft, and the company's Vultee Field design team at Downey submitted a series of designs to the Air Materiel Command at Wright Field between October 1945 and May 1946, as did other companies. Amazingly, Consolidated Vultee won the competitions for both the interceptor and the penetrating escort fighter, but the USAAF decided to award the latter to Lockheed in order to spread the business among contractors. In June 1946, the USAAF issued contract W33-038-ac14547, ordering two experimental examples of the Consolidated Vultee interceptor under the designation XP-92. (The Lockheed fighter was designated as the XP-90.)

With this, the design team rolled up their sleeves and went to work. At that time, the team was headed by Chief Engineer C. R. "Jack" Irvine, with Frank Davis as his assistant, Ralph Schick as Chief of Aerodynamics, and Adolph Burstein as Chief of Design. They designed the XP-92 with swept wings, still considered a leading-edge innovation in 1946, as well as a "V" tail configuration.

Almost from the beginning, the Consolidated Vultee engineers at Downey, who studied initial wind-tunnel model test data, were not entirely satisfied that the 35-degree swept wings would give the new aircraft the jump in performance that everyone had hoped for. There had to be another way.

Burstein is credited as having been the first to propose that Consolidated Vultee try a delta wing. A historic memo dated 5 July 1946, stating that "a 60-degree delta wing will be investigated this week" originated within his team. The Consolidated Vultee men were aware of theoretical work done on delta wings by Michael Gluhareff at Sikorsky, and they knew about the delta-winged aerodynamic data that had come from Alexander Lippisch by way of the USAAF Operation Lusty. Using the Langley wind-tunnel test data for the Lippisch DM-1, the company developed a proposal. Meanwhile, Ralph Schick learned that Lippisch himself was at Wright Field and arranged to travel to Ohio to confer with him. In turn, Lippisch came to San Diego for an extended stay in October 1946.

The die was cast. Consolidated Vultee, already being called Convair, was now in the business of building delta-winged aircraft.

The single Consolidated Vultee XB-36 prototype ready for its debut in August 1946. The largest bomber built to address the strategic requirements of World War II took to the air a year late, but found a definitive place in the Cold War. (Convair via Author's collection)

XF-92A in its new white U.S. Air Force color scheme cruises above the Mojave Desert. Note the bare metal control surfaces and full-span elevons (a combination elevator and aileron) on the trailing edge of the wings. (Convair via Author's collection)

As the company noted, "One of the outstanding advantages of the triangular wing appeared to be relatively low drag in the transonic region. Airfoils showed a sharp drag rise starting about Mach .9 and reaching a peak just above Mach 1, then tapering off as the 'drag hump' was left behind. Vultee Field studies prepared for the Air Force in November [1946] indicated a peak drag coefficient of only .048 for a 60-degree delta, compared with .072 for a 45-degree swept wing of equal area."

The idea that the USAAF had in mind for the XP-92's mission was similar to that which the Luftwaffe had in mind for the Lippisch P13a—and for the Lippisch/Messerschmitt Komet, for that matter. The mission was "point defense," the basing of interceptors in close proximity to locations such as industrial sites that were likely targets for enemy bombers. Jet or rocket engines, which became available in the 1940s, offered greatly improved performance over piston engines except for range. This meant that basing jet- or rocket-powered interceptors close to where they were to be used was the best way to get good use from them. As a powerplant for the XP-92, Consolidated Vultee engineers initially chose to use a ducted-rocket engine, described by Robert Bradley in his monograph on the program as "a ramjet with internal rocket and ramjet burners." ("Birth of the Delta Wing" in the *Winter 2003 Journal* of the American Aviation Historical Society.)

An amended contract dated November 1946, following the Lippisch San Diego visit, now specified that the subsequent XF-92A aerodynamic demonstrator would be powered by a Westinghouse 24C turbojet, but augmented by four booster rockets for fast acceleration. Consolidated Vultee initially specified the Westinghouse J30-WE-1 turbojet that delivered 1,560 pounds of thrust, but the engine configuration was destined to change several times as the program moved along. In a later retrospective of the program, NASA officially described the XP-92 as a "manned surface-to-air missile." With rocket propulsion, and within its point-defense role, it was indeed close to being such a thing.

One of Consolidated Vultee's early designs for the aircraft that actually made it to mock-up stage indeed looked just like a surface-to-air missile. It consisted of a huge, tubular-engine housing with triangular wings and vertical stabilizer attached. The primary ducted-rocket powerplant was to have been augmented by a half-dozen liquid-fuel rocket engines for a very fast takeoff.

Though its wing was a true delta and there were no horizontal tail surfaces, the XP-92 was more conventional in appearance than the DM-1. First of all, it had a fuselage. Consolidated Vultee also dispensed with Lippisch's idea of putting the pilot in the vertical stabilizer, but initially placed the cockpit inside the main engine spike in the center of the intake! In the meantime, though, a great deal of thought and engineering time was invested in ways for the pilot to escape from within the intake, in case of an emergency.

The company began work on the program at the Vultee plant in Downey, but when that facility was sold to North American Aviation in 1947, the project was relocated to San Diego. By December 1947, the XF-92A was finished and ready to be shipped out for wind-tunnel testing, which took place at the Ames Aeronautical Laboratory that NACA operated near the shores of San Francisco Bay.

The engine configuration continued to evolve. The specific engine that was now chosen for the aircraft was not the Westinghouse 24C as

As World War II neared its end, Consolidated Vultee, now calling itself Convair, moved quickly to become one of several American aircraft manufacturers to develop a jet bomber. For its XB-46, the company's designers used a conventional straight-wing design. However, for the company's first jet fighter, other Convair designers would be going in a different direction. (Convair via Author's collection)

When the USAAF began issuing requests for proposals for a new generation of high-technology jet fighters in August 1945, Convair responded with a swept-wing design that was ordered as a point-defense interceptor under the designation XP-92 in 1946. (Convair via Robert Bradley)

All the early designs for the XP-92 featured rocket or ramjet propulsion comprised of large rocket engines augmented by a varying number of smaller rockets. Here, in 1946, four are shown, but other proposals included more than a dozen. (Convair via Robert Bradley)

earlier planned, but the Allison J33-A-21. This 4,250-pound-thrust engine was subsequently replaced by a 5,200-pound-thrust J33-A-23 engine before flight testing began. The basic J33 turbojet was developed by General Electric from the Rolls-Royce Derwent, the production version of the original jet engine developed in England by Frank Whittle in the early 1940s. Whittle's had been the first jet engine outside Germany to power an airplane. In Germany, Hans von Ohain had preceded Whittle by less than two years.

Though General Electric had led in the development of the J33, the production license for the engine went to Allison, a division of General Motors that had manufactured 69,305 piston engines during World War II. The J33 was also then being used by Lockheed for its P-80 Shooting Star, America's first operational jet fighter.

Earlier designated as Consolidated Vultee Model 115, the project would be designated as Convair Model 7 in the new series of single-digit model numbers that would be used to designate the aircraft designed after World War II. There are, however, also references to it as Convair Model 1. The delta-winged variant is often referred to as Convair Model 7-002; possibly, the earlier swept-wing variation had been Model 7-001. The number is sometimes seen written as 7002, and there is one school of thought that states that 7002 happened to be the number on an engineering work order. Bob Bradley, who has written extensively on the program, believes that it was an internal accounting number and reports that within the walls of the engineering department at San Diego, it was pronounced as "Seven-Balls-Two."

The USAAF initially ordered two XP-92s and a structural test article, but the latter was later changed to a flying mock-up. Two years later, when the "P for Pursuit" nomenclature changed to "F for Fighter," these aircraft became XF-92s, and the single flying mock-up was designated as XF-92A. (The USAAF became the independent U.S. Air Force in September 1947.) The three tail numbers set aside were 46-682 through 46-684, although only one aircraft, the XF-92A, would be built and only one number assigned. Consolidated Vultee also proposed a carrier-based variant of the aircraft to the Navy, but the idea never got past the proposal stage and no designation was ever assigned.

By the time the aircraft was ready to fly, the designation had changed and so had the mission. The earlier notion of developing the aircraft into an interceptor had been superseded by the notion of using it simply to test the delta-wing concept. The Air Force formally decided against ordering operational F-92s to follow the single prototype, and the XF-92A officially became a research aircraft.

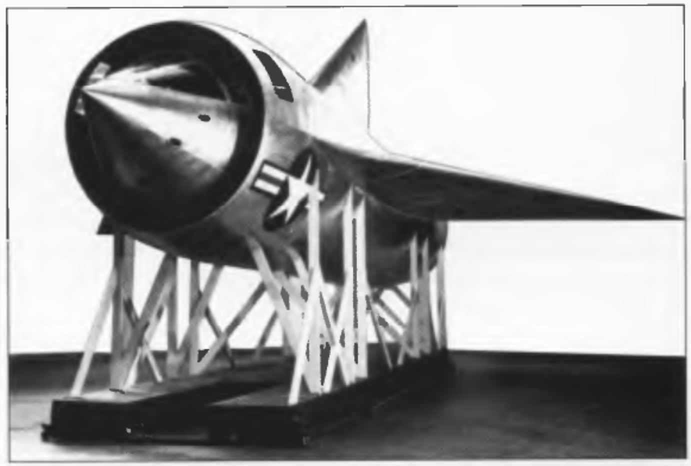
With Burstein now in charge as project engineer, the completed XF-92A was delivered to the Muroc Air Force Flight Test Center in California on 1 April 1948 with the J33-A-21 engine installed for taxi tests. Overhead, the Air Force was even then testing its first all-jet flying wing bomber, the Northrop YB-49. I digress to mention this, both to illustrate that the story of practical flying wings closely paralleled that of practical delta-winged aircraft, and to note that Muroc was renamed as Edwards AFB after Capt. Glen W. Edwards was killed in the crash of the YB-49 at the base two months later.

The first man to fly a delta-winged jet was Consolidated Vultee chief test pilot, Ellis D. "Sam" Shannon, an Alabama native with nearly two decades of flight experience, more than half of them as a test pilot. After six years with the Glenn L. Martin Company, Shannon had come to Consolidated Vultee in 1943 around the time the merger became effective, where he served as head of the company's Flight Research Department. He was the first to fly nearly every new model produced in San Diego, including later B-24 variants, the XB-32, and the XB-46. He also tested the company's successful postwar series of ConvairLiner commercial transports.

Shannon began working with the XF-92A in high-speed taxi tests at Muroc, and the first "flight"—actually an inadvertent hop—occurred during this process. On 9 June 1948, coincidentally just four days after Capt. Edwards was killed, Shannon was piloting the XF-92A when it lifted briefly from the runway. Over the following weeks, the J33-A-23 engine was installed.

The official first flight came on 18 September 1948, the first anniversary of the U.S. Air Force becoming an independent service. This began Phase I, the Consolidated Vultee phase, of the flight-test program. By the end of the year, Shannon had made 10 flights in the aircraft, reporting it easy to handle, albeit "a little sensitive"—his choice of words—on the controls. The second man to fly the XF-92A was Consolidated Vultee's Bill Martin, who made his debut flight on 21 December 1948. What Lippisch had planned in Germany during

By late April 1948, when the U.S. Air Force inspected this mock-up in San Diego, the XP-92 design had evolved from swept wings to delta wings. (Convair via Robert Bradley)



As shown in the 1948 mock-up, this proposed XP-92 located the cockpit within the spike in the center main ducted-rocket intake! (Convair via Robert Bradley)

As envisioned in 1948, the XP-92 pilot entered through the canopy's top panel. Bailing out in an emergency without being sucked into the ramjet presented a greater challenge. Convair proposed a system whereby the entire forward fuselage would be jettisoned. The turbojet engine was contained within the winged center section. (Convair via Robert Bradley)

Here the XP-92 is dwarfed by its own underwing auxiliary fuel tanks. Convair proposed this arrangement for the early part of a mission when a great deal of fuel would be used pushing the interceptor to high altitudes at great speed. One can't help but wonder about center-of-gravity issues during the rapid fuel burn-off. (Convair via Robert Bradley)

World War II came to fruition in the high desert of postwar California.

When Phase I of the flight testing wrapped up on 26 August 1949, Shannon and Martin had made 47 flights for a total of 20 hours and 33 minutes of flying time. The aircraft, now designated as XF-92A, was turned over to the Air Force for Phase II testing.

The first Air Force test pilot to fly the Convair delta was Maj. Charles E. "Chuck" Yeager, who made his XF-92A debut on 13 October 1949, the day before the second anniversary of his record-breaking first supersonic flight in the Bell X-1. The second Air Force pilot assigned to the XF-92A program, 1st Lt. Jim Fitzgerald, was killed in the crash of a Lockheed T-33 and was replaced by Maj. Frank K. "Pete" Everest.

Yeager would later recall that he found the aircraft to be an enjoyable one to fly, but Everest disagreed. In an interview with Barry DiGregorio, published in *Aviation History* magazine, he recalled that from his perspective, the XF-92A "wasn't a very stable airplane because they didn't attempt in those days to run stability tests on it, per se."

Though Everest completed what was the final Phase II U.S. Air Force test flight on 28 December 1949, Air Force pilots would continue to fly the aircraft intermittently for several more years.

Testing the XF-92A at supersonic speeds was always on the minds of the engineers who designed it, but those who test flew it found the aircraft incapable of piercing the sound barrier, so it was sent back to the factory to be re-engined with an afterburning Allison J33-A-29, delivering 7,500 pounds of thrust, and a lengthened fuselage.

The XF-92A during auxiliary power testing on the shores of San Diego Bay. It was here that Consolidated flying boats made their first flights. The XF-92A, however, would be trucked to the Mojave Desert for its debut. (Convair via Author's collection)

"Since [the pre-J33-A-29 aircraft] didn't have an afterburner on it, we dove it like you would an F-86 and other early jets to break the sound barrier," Pete Everest told Barry DiGregorio. "But we just couldn't get it to go supersonic. Convair then took it back to the factory and put an afterburner on it. We then were able to dive it supersonic. There was another argument that's still going on between the pilots and engineers. The engineers figured the XF-92A was going supersonic in level flight. But we pilots said it couldn't have, because we never saw any indication on the Mach meter or saw the airspeed indicator jump."

The one-of-a-kind XF-92A on the ramp at Lindbergh Field in San Diego, with Fort Worth–built early-production block B-36Bs being outfitted in the background. Convair's first delta, the XF-92A, rolled out in late 1947 but this picture was taken about a year later. (Convair via Author's collection)

After 14 months in San Diego, the aircraft returned to Edwards AFB in July 1951 with a new coat of gloss-white paint. Damaged in a December 1951 fire and plagued by other problems, however, the XF-92A remained grounded until June 1952, when the U.S. Air Force undertook an additional round of test flights. Yeager and Everest are recalled as having been the primary U.S. Air Force pilots, but the logbook also included the names of Col. Fred Ascani, Col. (later Gen.) Albert "Al" Boyd, Capt. Arthur "Kit" Murray, 1st Lt. James "Smash" Nash, Maj. Jack Ridley, and Capt. Joe Wolfe.

The Air Force completed its last XF-92A flight testing in February 1953, and turned the aircraft over to NACA. Convair then re-engined the aircraft yet again, retrofitting it with an Allison J33-A-16, delivering 8,400 pounds of thrust.

NACA's lead test pilot on the XF-92A program was Scott Crossfield, a World War II naval aviator, who later joined NACA's High-Speed Flight Station (now the NASA Dryden Flight Research Center) at Edwards AFB as an aeronautical research pilot. In addition to the XF-92A, he flew numerous test aircraft, including the Bell X-1, the Northrop X-4, and the swing-wing Bell X-5, as well as the Douglas D-558-I Skystreak and the D-558-II Skyrocket.

Crossfield made the first flight in the re-engined XF-92A on 9 April 1953. As had been the case for earlier pilots, Crossfield found the controls to be temperamental, and he also detected a tendency of the nose to pitch up in high-speed turns. This was addressed by the addition of wing fences that were only partially successful in mitigating the problem.

NACA documentation, summarized officially by the National Aeronautics and Space Administration, notes that Crossfield flew a total of 25 flights in the XF-92A through 14 October 1953. NACA recalls that "the initial 13 flights were for data on static longitudinal stability; dynamic stability; directional control; longitudinal and lateral stability and control; and low-speed stability and control. These were followed by 10 flights to test different wing-fence configurations. The wing fences were designed to control the tendency of swept-wing aircraft to pitch up at low speeds and in turns. The initial six flights were made at speeds under Mach 1. The last four were for data on low-speed lateral and directional control with the wing fences. On one flight, the

Aside from an "unintentional hop" during taxi testing, test pilot Sam Shannon made the first flight in the Convair XF-92A on 18 September 1948 over the Air Force Flight Test Center at Muroc, California, which was renamed Edwards AFB soon thereafter. (Convair via Author's collection)

Dwarfed by a massive B-36, the XF-92A poses on the ramp in San Diego. The dramatic contrast in scale illustrates the wide range of products that flowed from the drafting rooms and factories of America's airplane makers in the technological watershed years following World War II. (Convair via Author's collection)

The XF-92A prototype is seen here at Convair's San Diego factory with its distant cousin, a Model 240 ConvairLiner. From the time of its debut in 1947, piston engines were standard equipment in the Model 240. In 1950, however, the first Model 240 was experimentally re-engined with Allison 501-A4 turboprops and renamed "Turbo-Liner." Although Convair did not build a production series of turboprop airliners, many ConvairLiners were later re-engined with both Allison and Rolls-Royce turboprops. (Convair via Author's collection)

modified wing fences buckled during the test. The XF-92A undertook two low-speed lateral and directional control flights without the wing fences."

Both of the latter flights occurred on 14 October, and when the XF-92A landed on the lake bed after the second one, the nose gear collapsed as Crossfield turned off the runway. He was not hurt, but the XF-92A was never repaired for further flight testing. It was retired, having logged around 62 hours of flying time on 119 separate flights.

A month later, on 20 November 1953, Crossfield became the first man to fly at twice the speed of sound as he piloted the Douglas D-558-II to a speed of Mach 2.005, or 1,291 mph. In 1955, he joined North American Aviation as its chief engineering test pilot. In this job, he became one of the key men in the design, development, and testing of the X-15 research plane, in which he made flights that approached three times the speed of sound.

Designated as a research program, the XF-92A experience was exactly that. Convair had learned important technical lessons that were being applied to the F-102 even before the XF-92A's nose gear collapsed. The company observed that its studies proved the delta to be exceptionally stable in thin air, and to have good low-speed handling qualities, due in part to the absence of a distinct stall point. "Additionally," Convair notes in its official records, "it was realized that the triangular shape was inherently strong, permitting the structure to be at once thin and rigid; and that the delta's area (larger than that of a comparable straight or swept wing) implied greater internal volume for fuel."

The program also had an unexpected legacy. The XF-92A was caught by Hollywood's cameras for two movies where filming was done at Edwards AFB in the early 1950s. The first to be released was *Toward the Unknown*, starring William Holden, which reached the big screen in August 1956. A year later, the long-delayed *Jet Pilot*, produced by Howard Hughes and starring John Wayne, was finally released. For the latter film, the XF-92A was painted to represent the imaginary MiG-23 (the real MiG-23 would not appear for another decade), but its scenes were omitted from the final cut. In *Toward the Unknown*, the XF-92A was cast in the role of the F-102. This bit of casting ironically hit close to home, as the XF-92A really did serve as the opening act for that aircraft.

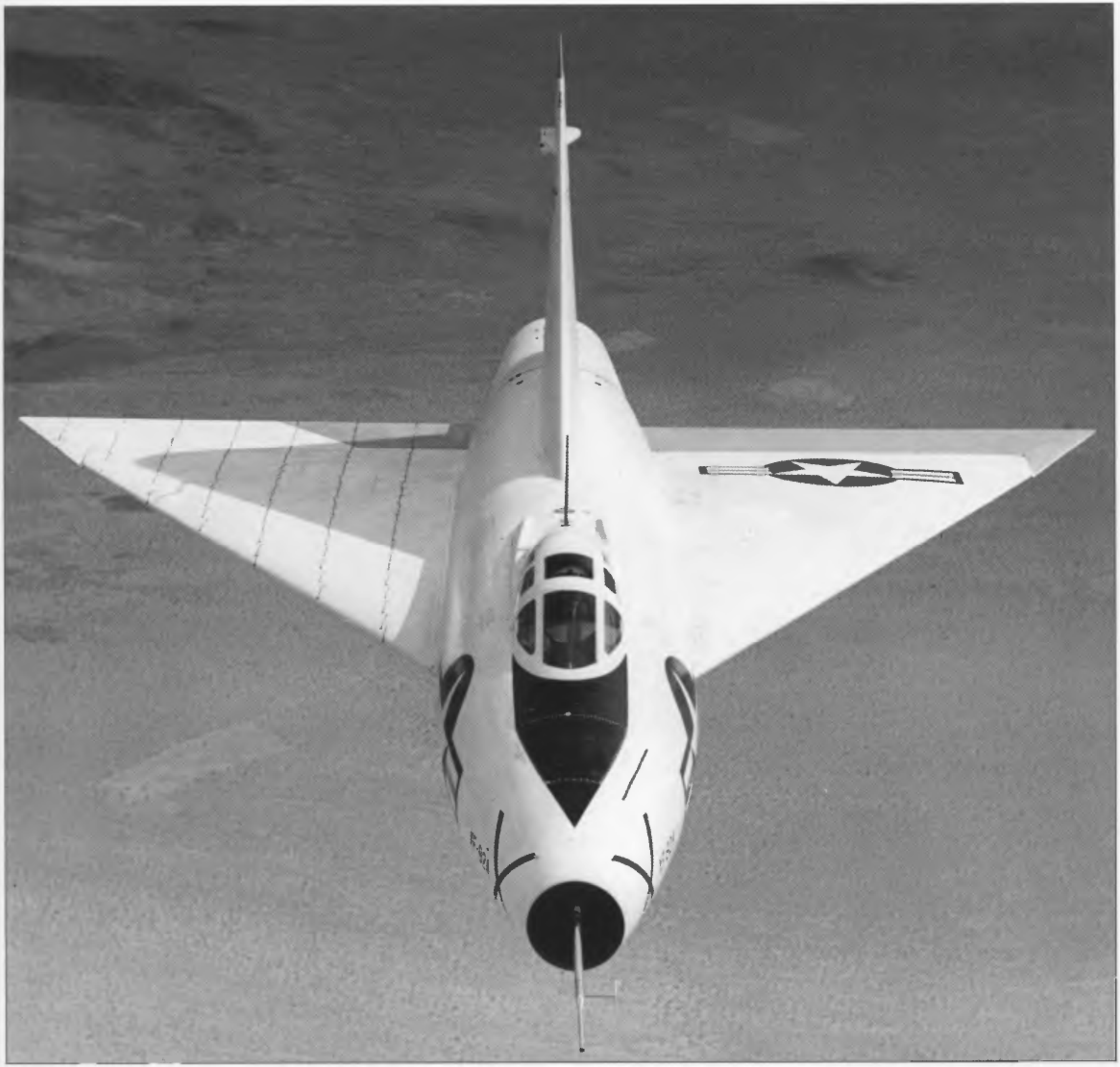
The real movie star, the single XF-92A, was then bailed to the Air Force Display Program and trucked around the country for display at state fairs. After being in the possession of the University of the South in Sewanee, Tennessee, for several years, it was returned to the

This photograph of the Convair XF-92A on the dry lakebed at Muroc was taken on 13 April 1949, a year after the aircraft first arrived at the base for its initial taxi tests. (Convair via Author's collection)

After being re-engined with an afterburning Allison J33-A-29 turbojet engine delivering 7,500 pounds of thrust, the XF-92A returned to Edwards AFB in July 1951 with a new coat of gloss-white paint. (Convair via Author's collection)

Pictured here are some of the key men involved with the development of the first Convair deltas. From left are: Tom Hemphill, the project manager in the later part of the program; Chief Aerodynamicist Ralph Schick; Bill Fox; and Chief of Design Adolph Burstein. (Convair via Author's collection)

Sam Shannon seems to be saying, "I'd rather be anywhere but here," as he holds an XF-92A model during a radio interview with Jack Hausman of KSDO on 7 June 1951. At the left are Jack Mason, Convair's wind-tunnel manager and Ralph Schick, Convair's chief aerodynamicist. (Convair via Author's collection)



The XF-92A in flight over Edwards AFB, circa 1952. The tufting seen on the right wing was photographed during flight and the results were used to measure airflow direction across the wing. By this time, the aircraft was seen only as a research vehicle, and not as a prototype. (Convair via Author's collection)

service, and eventually went on display at the National Museum of the Air Force at Wright Patterson AFB near Dayton, Ohio.

For their contributions to delta-winged aircraft as epitomized by the XF-92A, Frank Davis, Ralph Schick, and Adolph Burstein went on to receive the National Aircraft Design Award from the American Institute of Aeronautics and Astronautics—but not until 1981.

In the meantime, under the theory of "imitation being the sincerest form of flattery," the team was honored by other new delta-winged aircraft that started cropping up from Gloster and Avro in the United Kingdom, Dassault in France, and in many other quarters.

What the Air Force acquired under Contract W33-038-ac14547 had cost $4.5 million (roughly 10 times that in current dollars). That $4.5 million bought just one airplane but was the price of admission into the world of delta-winged aircraft that would define both Convair and the U.S. Air Force's Air Defense Command for a generation.

U.S. Air Force test pilot Maj. Chuck Yeager climbs aboard the XF-92A at Edwards AFB. Various Air Force pilots flew the aircraft during the second half of 1951, until it was damaged in a fire in December of that year. Air Force testing resumed in June 1952 and continued until February 1953 when NACA took over the program. (Convair via Author's collection)

THE U.S. AIR FORCE AIR MATERIEL COMMAND

Through the years, the Air Force and its predecessor organizations have gone back and forth over the issue of having both logistics and supply activities, as well as research and development activities, combined into a single major command. The functions were originally separate, but were merged into the Materiel Division of the U.S. Army Air Corps when the latter was created in 1926, and remained as such when the Air Corps became the U.S. Army Air Forces (USAAF). In 1941, immediately after the United States entered World War II, they were separated as the Air Technical Service Command and the Air Service Command. These were, in turn, merged into a single Air Materiel Command in 1944.

The Air Materiel Command remained as such when the USAAF became the U.S. Air Force in 1947. The Air Research & Development Command was officially created in February 1950 when the research and testing function was spun off from the Air Materiel Command. The activities of both agencies spread across the globe, but were centered at Wright Field (later Wright-Patterson AFB), near Dayton, Ohio. As a practical matter, the two commands worked together closely and many of their activities overlapped, although the attention of the Air Materiel Command was primarily focused on providing support for aircraft *after* they had been "researched and developed."

As the U.S. Air Force developed new aircraft during the 1950s, the Air Research & Development Command was the agency doing the developing, although this work was always done on behalf of an operational command that would be the ultimate "customer" for the aircraft. In the case of the F-102 and F-106, the Air Defense Command was the ultimate customer. In the case of the B-58, the Strategic Air Command was the ultimate customer, but the Air Research & Development Command had the job of running the program on behalf of the end user until the aircraft were ready for operational use. Theoretically, new aircraft were "owned" by the Air Research & Development Command from the point at which they were turned over to the Air Force by the manufacturer after the first few flights. In general terms, it can be said that the Air Research & Development Command operated the aircraft that had "X" and "Y" prefixes, and these prefixes were dropped as the aircraft were ready to become operational for the end user.

During the development and test phase, it was not necessarily a foregone conclusion that an operational command would ultimately take over the program, even if it was being developed to meet a specific requirement defined by an operational command. Such was the case with the XF-92A. If the need was not being met, an operational command would not necessarily sign on. Especially during the 1950s, a great many aircraft were built and tested, but neither deployed nor put into production. These aircraft would live out their entire life with the Air Research & Development Command.

In April 1961, the Air Research & Development Command became the Air Force Systems Command, while the Air Materiel Command became the Air Force Logistics Command. In 1992, the two merged again to form the Air Force Materiel Command—an entity that had the equivalent function of the pre-1950 Air Materiel Command.

At one point during its years of managing the XF-92A program, the U.S. Air Force conducted this photo session in which the pilot was driven out to the aircraft by an armed, white-hatted Air Policeman. This was probably not standard procedure, but it looked pretty impressive in the publicity photos. (Convair via Author's collection)

CONVAIR (CONSOLIDATED VULTEE) XF-92A (CONVAIR MODEL 7, CONSOLIDATED MODEL 115) SPECIFICATIONS

Dimensions
Wingspan: 31 feet 4 inches (9.55 meters)
Length: 42 feet 6 inches (12.99 meters)
Tail height: 17 feet 9 inches (5.37 meters)
Wing area: 425 square feet (39.5 square meters)

Weights
Empty: 9,078 pounds (4,118 kilograms)
Gross: 14,608 pounds (6,626 kilograms)

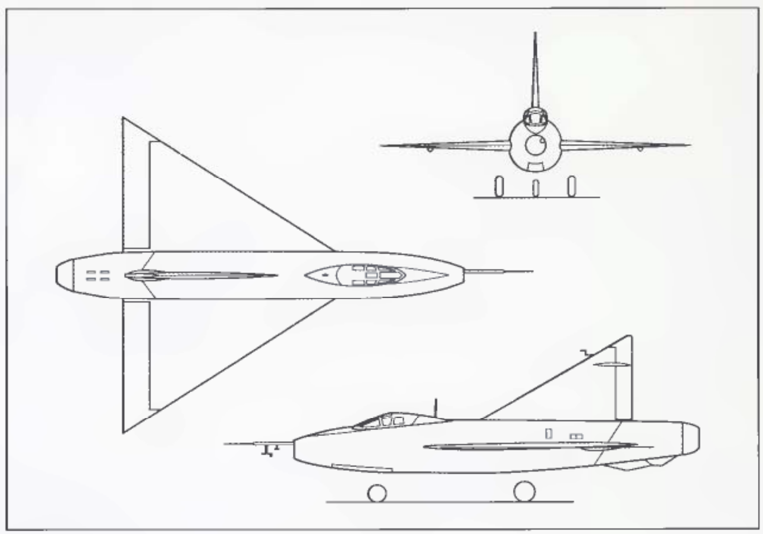
Powerplant
1 Allison J33-A series turbojet engine rated at up to 7,500 pounds of thrust

Performance
Maximum speed: 718 mph (1,160 kph)
Service ceiling: 50,750 feet (15,450 meters)
Rate of climb: 8,135 feet (2,480 meters) per minute

Armament
None

A Good color view of the XF-92A on the lakebed at Edwards AFB. On its 119th flight and last-ever landing here on 14 October 1953, the nose gear collapsed as NACA test pilot A. Scott Crossfield turned off the runway. The aircraft was then retired after logging approximately 62 hours of flight-test time. (Convair via Author's collection)

The XF-92A carried a blue-and-gray "MiG-23" scheme for the Howard Hughes movie Jet Pilot. Though shot in 1950, security issues prevented the movie's release until 1957—sadly minus the XF-92A footage. (NASA via Terry Panopalis)



This three-view drawing of the XF-92A gives a good depiction of the critical aerodynamic relationship between the aircraft's delta wings and the vertical stabilizer. Note the narrow track of the main landing gear as seen in the front view. (Convair via Author's collection)

Chapter Four

Developing the F-102 Delta Dagger

2 October 1953 marked the completion date of Convair's first YF-102, only five months and one day after design work had officially ended. (Convair via Author's collection)

According to Convair corporate historian Howard Welty, the most important military production at Convair in the immediate postwar years was that of delta-winged aircraft. The requirement to be addressed by the aircraft that was to become the F-102 was the high-priority need for an interceptor to defend the United States against Soviet bombers. The XF-92A paved the way, giving the company the confidence to propose no other wing configuration than the now-proven delta for the jet aircraft that was to become its single largest postwar aircraft program.

One of the most effective uses of air power in World War II had been the successful strategic bombing operations conducted against Germany and Japan by the USAAF. Aside from Allied strategic planners, perhaps few people in positions of power understood this better in the postwar world than Soviet strategic planners, many of whom had seen the effects of the Allied strategic bombing campaign as they marched through the battered Third Reich in the spring of 1945.

As the wartime alliance of convenience ("the enemy of my enemy is my friend") between the Soviets and the Western Allies turned to animosity and the Cold War began, both sides began to acquire the hardware to potentially conduct such a campaign against the other. The USAAF (U.S. Air Force after 1947) had the Boeing B-29, the biggest strategic bomber in the world, but it was soon discovered that the Soviet Union was developing a near-exact copy (reverse engineered from interned B-29s) that was designated as the Tupolev Tu-4.

Both sides dreamed bad dreams of seeing their skies darkened, as had the skies over Germany when the USAAF and the Royal Air Force Bomber Command came calling during World War II.

The dreams grew especially nightmarish when the Soviet Union exploded its first nuclear weapon in 1949. In the United States those who imagined and feared enemy bombers overhead still had relatively fresh memories of that infamous surprise attack on the morning of Sunday, 7 December 1941. American military planners often articulated the phrase "nuclear Pearl Harbor" when discussing air defense against the growing Soviet nuclear menace.

The air forces on both sides of the Iron Curtain were developing new strategic bombers. And to put light into the darkness of the

Even the mysterious shape of the delta-winged, dart-shaped object required draping to obscure it. In 1953, anywhere outside the inner byways of the Convair plant such a loosely wrapped "package" would have caused whispers and double-takes, but these people had seen it many times by now. (Convair via Author's collection)

Literally still shrouded in secrecy, the harbinger of the world's first operational series of delta-winged aircraft emerged from its San Diego birthplace. (Convair via Author's collection)

The first YF-102 prototype (52-7994) rolled out in the early autumn of 1953 and was trucked up to Edwards AFB for its debut flight on 24 October. (Convair via Author's collection)

nightmare, they also gave a parallel high priority to aircraft that were to intercept such bombers—and prevent the specter of a nuclear Pearl Harbor.

As early as October 1948, a few months after Soviet dictator Joseph Stalin brought the Iron Curtain crashing down in the form of the blockade of Berlin, the Air Force began considering plans for an advanced, specially designed interceptor. A first generation of jet fighters was already reaching flight test, and this generation would include all-weather interceptors such as the North American F-86D Sabre Dog, the Northrop F-89 Scorpion, and the Lockheed F-94C Starfire, but the Air Force could already foresee that they would have limitations. Not the least of these was that these interceptors would all be subsonic in level flight.

In planning its interceptor fleet in the late 1940s, the U.S. Air Force considered a variety of applications and a variety of types of aircraft. Conceptually distinct from the more-versatile, all-weather interceptors in the minds of Air Force leaders were the point-defense interceptors whose role was addressed in the original concept of the XP-92 program. The emphasis with point-defense interceptors was fast reaction, wherein speed took precedence over range, hence the incorporation of rocket propulsion in this earlier Convair program. Another such point-defense interceptor (whose development paralleled that of the XP-92/XF-92A) was the Republic Aviation XF-91A Thunderceptor, which first flew in May 1949 and which incorporated rocket propulsion as well as jet propulsion. After the XF-92A project became a research program rather than a tactical program, the XF-91A was briefly considered as an interim point-defense interceptor. However, this program was terminated after two prototypes were built.

By the late 1940s, with a variety of jet fighters, including all-weather interceptors, in development or flight test, the U.S. Air Force began to plan long term, beyond the need to intercept existing Soviet bombers. Indeed, planners began to consider the requirement for an interceptor that could match or surpass the speed and altitude of

Sunrise over Edwards AFB as one of the eight Model 8-82 second-generation YF-102 aircraft is prepped for its day's work, probably in early 1954. The aircraft flying above may be the second of the two Model 8-80 first-generation YF-102 aircraft (52-7995). (Convair via Author's collection)

Soviet intercontinental jet bombers, which were anticipated to be coming on line in the future.

The Air Force's Advanced Development Objective that was issued on 13 January 1949 called for a sophisticated, high-altitude, all-weather interceptor that addressed all the shortcomings of the first-generation jet interceptors. Officially designated as Weapon System 201A (WS-201A), this still-hypothetical interceptor was also referred to as the 1954 Interceptor, because it was planned to be operational five years from 1949.

Designating the new program as a weapons system rather than as an aircraft marked a new way of thinking for the Air Force that would become more and more evident in the following years. In the old days of the Air Corps, the service bought airplanes and engines. The same engine type powered several aircraft types. By the end of the 1940s, however, it was no longer that simple. The Air Force recognized that "the increasing complexity of weapons no longer permitted the isolated and compartmented development of equipment and components which, when put together in a structural shell, formed an aircraft or missile." It concluded that the new interceptor should be developed in conformity with the Weapon System Concept. This concept (yet to be tried) integrated the design of the entire weapons system, making each component compatible with the others.

Among the components of Weapon System 201A were the airframe (of course), which was designated as *Project MX-1554*, and an electronic control system, which was developed under the designation *Project MX-1179*. This system actually came first, with the Hughes Aircraft Company being awarded the contract in October 1950 before an airframe contract was granted. Hughes had already developed such systems for earlier interceptors, and had previously won the MX-904 contract for the Hughes Falcon family of air-to-air (air intercept) missiles with which many early interceptors were equipped. Previously known as the Dragonfly, the Falcon itself was originally given the fighter designation XF-98, but it was by now designated

A flurry of activity swirls around the first YF-102 as it rests on the lakebed at Edwards AFB in preparation for a test flight, possibly its first, which occurred on 24 October 1953 with Convair test pilot Richard Johnson at the controls. (Convair via Author's collection)

GAR-1. Later, Falcons would be redesignated AIM-4, with later variants designated AIM-26 and AIM-47.

It should be noted that the Hughes Aircraft Company was one of two "aircraft" companies owned by the eccentric industrialist and aviation aficionado Howard Hughes. The other was the Aircraft Division of the Hughes Tool Company, a very successful enterprise co-founded in 1909 by Hughes' father to build oil-drilling equipment, especially a unique drill bit patented by the elder Hughes. The Aircraft Division built airplanes such as the sleek single-engine H-1 racing plane, the twin-engine XF-11 prototype reconnaissance aircraft, and the mammoth eight-engine HK-1 Spruce Goose flying boat, while the Hughes Aircraft Company never actually built an airplane. It would, however, become a major developer and manufacturer of missiles, spacecraft, and electronic systems. The Aircraft Division, run for many years as a sort of hobby for its founder, later became Hughes Helicopters. Howard Hughes himself never had any hands-on involvement in the Hughes Aircraft Company.

As Hughes was winning the MX-1179 electronics portion of WS-201A, several aircraft manufacturers were competing for the MX-1554 airframe component. The request for proposals, issued by the Air Force on 18 June 1950, called for "an airframe structurally capable of withstanding a speed of more than Mach 1, at an altitude of 50,000+ feet." The request for proposals also mandated the 1954 operational date. It was also anticipated that the Air Force would issue Phase I development contracts to more than one bidder. The idea was that a final decision on a production contract would be postponed until the MX-1554 mock-ups were inspected.

Seven months later, the bidding closed with proposals from a half-dozen manufacturers. On 2 July 1951, the Air Force decided that there were three winning proposals, but soon reduced it to just two MX-1554 finalists, the Convair Model 8 and the Republic Aviation Corporation Model AP 57. The two firms were ordered to go ahead with mock-ups and the fighter designations F-102 and F-103 were assigned to the two projects. The third one from Lockheed had been eliminated because the Air Force decided that three parallel projects would simply be too expensive. The Lockheed entry, diverted to a role as a fighter, would win a large production contract under the designation F-104.

Convair's Sam Shannon piloted the second YF-102 on its debut flight at Edwards AFB on 11 January 1954, two months after the first YF-102 prototype was damaged beyond repair in a non-fatal hard landing. (Convair via Author's collection)

The Convair Model 8 was a pure, delta-winged aircraft, which had direct and obvious roots in the company's Model 7, the XF-92A. The Republic AP 57 was a missile-shaped aircraft with short delta wings, but also with delta-shaped horizontal tail surfaces.

Even though there were two finalists, the Convair Model 8 was the clear winner to become the 1954 Interceptor. The Request For Proposals had called for a sophisticated interceptor, but it *also* called for a 1954 Interceptor, and the Republic entry was deemed too sophisticated to be ready by 1954. It was an all-titanium turbojet/ramjet-powered Mach 3 aircraft capable of operating at 80,000 feet, which exceeded the Air Force's specifications. On 11 September 1951 the Air Force issued its Phase I order for the Convair Model 8, which stipulated MX-1554 performance requirements that included a speed of Mach 1.88 and an operational altitude of 56,500 feet.

However, the Air Force looked ahead and in June 1954, ordered three examples of the XF-103 to be built as Weapon System 204A. It was a slow process, due to adversities faced in titanium alloy fabrication and engine development. The first flight was postponed again and again to 1958, but the F-103 program was finally terminated a year before that projected date.

Meanwhile, Convair moved ahead with its Model 8.

The Air Force had confidence in the Convair Model 8, and that confidence was well placed. However, there were other components within Weapon System 201A that would slow down the whole process. The Hughes MX-1179 electronic control system was behind schedule, and so too was the planned engine, the 15,000-pound-thrust Wright J67 turbojet, which was based on the British Armstrong Siddeley Sapphire. The existing Westinghouse turbojet engine had previously been planned for use in the prototype and, in December 1951, the Air Force authorized Convair to go ahead and use the J40 for all of the early aircraft until the J67 became available.

On 24 November 1951, only two months after anointing the Convair delta as the MX-1554 winner, the Air Force decided to move quickly by ordering the F-102 into production. In doing this, the Air Force was implementing the so-called "Cook-Craigie Plan," developed by Lt. Gens. Orval Cook and Laurence "Bill" Craigie of the Air Materiel Command to speed up the evaluation and production of new aircraft types. It had long been standard practice for a new aircraft program to begin with the evaluation of one or two hand-built prototypes; under the Cook-Craigie Plan, certain aircraft would enter into what is now called low-rate-initial-production even before flight testing was completed. The theory was that it would be more expeditious to fine-tune the design on the assembly line rather than to wait for the conclusion of flight testing to start production. The Cook-Craigie Plan helped to encourage the practice of small numbers of many different prototype aircraft being built.

The value to the Air Force of Cook-Craigie was that if the program turned out to be a "go," much of the engineering had already been done. To quote the official Air Force position, as articulated by Cook and Craigie, this "was only applicable where you had a high degree of confidence that you were going to go into production," although a large number of prototypes didn't go into production.

By 1951, it had gradually become apparent that the 1954 Interceptor would not be operational in 1954. Fortunately, the well-placed confidence that the Air Force had in the Convair Model 8 airframe led the service to authorize a two-track development of the WS-201A interceptor as part of its 24 November plan. The initial goal would be met with the Model 8-10 equipped with the J40 engine. Even with this engine, the aircraft would be superior to other existing interceptors. This interim interceptor was to be designated as F-102A and equipped with components such as an electronic control system that were as advanced as possible, although admittedly not what had been hoped for in the best case form of WS-201A.

The more advanced interceptor, WS-201B, was now being referred to as the "Ultimate Interceptor." Initially designated as F-102B, this aircraft would evolve considerably and would eventually be redesignated as the F-106.

By the end of 1951, Convair had begun the engineering and pre-production work for the first 10 YF-102 service test aircraft. The first two, known internally as Convair Model 8-80, were given tail numbers 52-7994 and 52-7995. The next eight, Convair Model 8-82, were numbered 53-1779 through 53-1786. Initially, 42 aircraft were "under procurement," with limited production not scheduled to begin until April 1954. This was 10 months behind the December 1951 plan. The Air Force noted that accelerated production of a combat-ready, fully tested weapons system was not anticipated until December 1955.

At the same time that Weapon System 201A was evolving into the F-102 interceptor, the Air Force was making plans for training flight crews to operate the F-102. By the early 1950s, the standard U.S. Air Force jet trainer was the Lockheed T-33, a two-seat variant of the F-80, the service's first jet fighter. However, the shortcomings of the T-33 as an interceptor trainer had been illustrated during pilot transition programs involving both the F-86D and the F-94. As it was described, "neither Air Defense Command nor the Air Training Command believed that this training could be provided with conventional type jet trainers."

With this in mind, the Air Force requested that Convair develop Weapon System 201L, the parallel trainer for Weapon System 201A. Convair responded with its Model 8-12, a dual-seat variation on the Model 8. On 16 September 1953, the Air Force formally authorized production of the Model 8-12 under the designation TF-102A, although initial acquisition was delayed and production was postponed

The fifth Model 8-82 YF-102 in flight during an early test mission. By the time the 8-82s rolled out, the new Area Rule was a known factor, so these barrel-shaped aircraft served in a lame-duck role in the evolution of the F-102 story. (Convair via Author's collection)

because of the developmental problems being encountered in the interceptor program.

Convair spent the better part of 1952 building a mock-up of the F-102, which was ready for inspection on 18 November. In the meantime, Hughes was estimating that the MX-1179 electronics would not be ready until October 1955, so the Air Force ordered the company to prepare an interim control system for the F-102 as soon as possible. Hughes proposed the E-9 system, a modified variant of the E-4 fire-control system that the company was building for the F-86D. The E-9 (later known as MG-3) was then being used for the Northrop F-89 interceptor. Other electronics specified for the "interim" F-102 were the AN/ARR-44 data link and the AN/ARC-34 miniaturized communication set.

On paper, the substitutions all looked like reasonable solutions to the delay. Unfortunately, as the program evolved into 1953, it was becoming apparent that they were not. As any aircraft designer understands, there is one nagging concern that, above all others, governs nearly any decision that is made with regard to components, and that was weight. With the new Hughes proposal, the E-9 fire-control system was heavier than the projected MX-1179 system, so the original

A family portrait of YF-102s on the ramp at Edwards AFB early in the flight-test program in 1954. All are Model 8-82s except the aircraft second from top, which is the second of two prototype Model 8-80 aircraft, which arguably should have been designated XF-102. These two aircraft differed slightly in design details, including a slightly redesigned nose and the additions to the vertical stabilizer that were made in an effort to improve lateral control and reduce buffeting. (Convair via Author's collection)

calculations had to be re-examined. Next, the F-102 wound up with a heavier engine than that for which engineers had planned. The Westinghouse J40 was the most powerful American turbojet engine that was approved for production when the F-102 was confirmed as an interim interceptor, but it was shown to be inadequate to give the aircraft the intended minimum speed and altitude. The Pratt & Whitney J57-P-11, rated in the 10,000-pound-thrust class, would be ready to enter production in about February 1953, but it was too heavy to meet the weight limitations into which the engineers hoped to shoehorn the F-102.

The engineers also began to encounter unanticipated design issues. Early in 1953, wind-tunnel tests conducted at NACA's 8-foot high-speed tunnel at the Langley Research Center showed that aerodynamic drag (air resistance) inherent in the F-102's design would hinder its desired performance. Theoretically, smooth, sleek, pencil-straight fuselages with thin wings and powerful jet engines were assumed to be ideal for supersonic aircraft. However, in the early 1950s, the so-called "transonic region" involving speeds from Mach 0.9 to Mach 1.1 had not yet been explored systematically in wind tunnels. Contrary to what was supposed intuitively, bullet-shaped aircraft were *not* ideal for supersonic flight.

As the data was being reviewed, NACA aerodynamicist Richard Whitcomb and his team at Langley discovered that as the high-speed air flowed around the wind-tunnel models, they expected to see shock waves forming near the nose, but they were startled to find additional strong shock waves established behind the trailing edges of the wings. The unexpectedly high drag was caused by the aircraft having to overcome the energy losses created by these extra shock waves, which were described as being like "aerodynamic anchors."

To his own amazement, Whitcomb calculated that drag at transonic speed depends almost completely on distribution of the aircraft's cross-sectional area along the direction of flight. This had earlier been observed by Heinrich Hertel and Otto Frenzl at Junkers in Germany during World War II, and discussed by Wallace Hayes at the California Institute of Technology. Whitcomb discovered it independently in 1952 and was the first to directly apply it to the design of an aircraft. That aircraft was the F-102A.

Whitcomb proposed his "Area Rule," stating that the fuselage should be narrowest where the wings were attached and widened at the trailing edges. He suggested the radical idea that the pencil-straight fuselage should be replaced with a "wasp-waist" or "Coke-bottle"-shaped fuselage, with a wide tail. Many commentators also referred to it as the "Marilyn Monroe" shape, after the 1950s Hollywood sex goddess who was said to have the most perfectly shaped female body.

Even today it sounds counter-intuitive, but Whitcomb overcame drag by essentially redesigning the cross section and shape of the F-102A's fuselage. He indented the fuselage adjacent to the center of the wing, and added more fuselage volume near the tail. This increased performance considerably.

The idea seemed peculiar, but the wind-tunnel data convinced Convair engineers to redesign the YF-102. Wind-tunnel testing

The first YF-102A (Model 8-90) at Edwards AFB, where it made its debut flight in December 1954. (Convair via Author's collection)

Because the Hughes MX-1179 electronics package was running behind schedule, the Air Force ordered the company to prepare an "interim" control system for use in the F-102A. For this, Hughes proposed the modular E-9 (MG-3) system, a modified variant of the E-4 fire-control system that the company was building for the North American F-86D Sabre. (Convair via Author's collection)

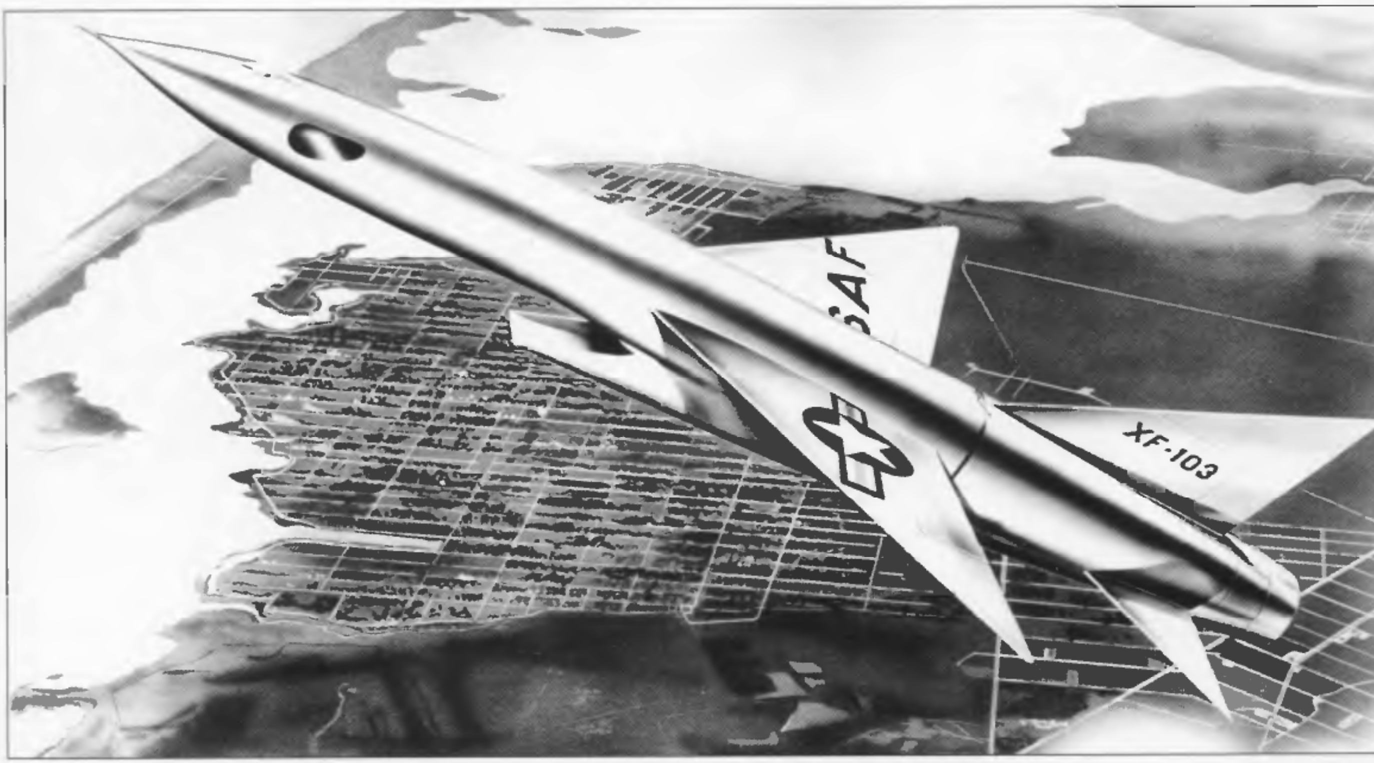
conducted in October 1953 showed that an F-102 designed according to the Area Rule would meet Air Force supersonic requirements. By now, the first of the 10 YF-102s were being built at San Diego without the redesigned Coke-bottle fuselage, but the new fuselage form would be introduced in subsequent production aircraft.

Later, the Pilotless Aircraft Research Division (PARD) at Langley tested rocket-powered models of the F-102 in both configurations—before and after application of the Area Rule. These vertical-launch test flights occurred at Wallops Island on the Virginia shore. According to James Hansen in his book published by the NASA History Office, *Engineer in Charge: A History of the Langley Aeronautical Laboratory, 1917–1958,* these tests took place later in the 1950s, after the Area Rule had been incorporated into production series F-102A aircraft.

The first YF-102 prototype—designed with a straight fuselage before Convair engineers were fully aware of the implications of the Area Rule—made its initial flight at Edwards AFB on 24 October 1953 with Convair test pilot Richard Johnson at the controls. The sluggish performance afforded by the straight fuselage, as was predicted by wind-tunnel tests, was soon apparent in flight testing. However, these test flights ended less than two weeks later when the first prototype lost power and bellied-in during takeoff on its intended seventh flight on 2 November. Johnson survived, but the initial YF-102 was written off.

The second YF-102 (52-7995) was first flown on 11 January 1954 by Sam Shannon. Two weeks later, on 27 January, he managed to exceed the speed of sound only during a dive. Maj. Gen. Al Boyd, who became the first Air Force pilot to fly the aircraft on 28 April, also reported disappointment. The performance of the YF-102 was, as foreseen by Whitcomb, unsatisfactory all around. In level flight, aerodynamic drag limited it to Mach .98 and it had a ceiling of 48,000 feet, well below the 56,500 feet specified in the Phase I requirements. Meanwhile, the F-86D, the interceptor based on the earlier generation F-86 fighter, had become fully operational in mid 1953 with Mach 0.9 performance and a service ceiling of 49,600 feet.

This was the point in the Convair Model 8 program where one is tempted to say "back to the drawing board," but thanks to the 1953 wind-tunnel tests, the "drawing board" portion of the solution was



The nearest thing to a competitor that the Convair F-102 had was the Republic F-103. It was a far more complex all-titanium turbojet/ramjet design that promised a higher service ceiling and Mach 3 performance. Prototype XF-103s were ordered in 1954 as the YF-102 was well into its early test-flight phase, but the XF-103 never made it past the mock-up stage and was canceled four years later. (Author's collection)

The straight lines of the YF-102 fuselage represented the best engineering guess of aerodynamic sleekness before the discovery of the Area Rule. (Convair via Author's collection)

The curvaceous Coke-bottle lines of the Area Ruled YF-102A Hot Rod are in obvious contrast to those of the YF-102. (Convair via Author's collection)

already known. It was "back to the tooling." Unfortunately, under the Cook-Craigie Plan, much of the production tooling had already been done, under the theory that starting tooling early would save important time later. The idea behind Cook-Craigie was that it would take less time to make changes in tooling than to make a late start in beginning the tooling.

Cook-Craigie presupposed that engineering changes could be made on the assembly line, just as they had during many (if not most) programs during World War II, and that this would be cheaper in the long run than delaying the start of the program. However, in the case of the YF-102, two thirds of the 30,000 tools that Convair had already purchased through October 1953 had to be scrapped—even as the last of the initial 10 YF-102s were being built!

Obviously, the replacement cost in tooling alone was both huge and unanticipated. A cost review in April 1955 revealed that 32,000 tools had been completed based on the original YF-102 design, but more than 24,000 of them had to be discarded because of the major changes to the YF-102A. The total cost for design and manufacture of these tools had been $40,442,000—and $19,362,000 had been wasted by throwing the tools away.

Meanwhile, many design changes came during the wind-tunnel program and subsequent data analysis as Convair engineers applied the Area Rule to the program. The wings had to be moved back and redesigned with cambered leading edges and reflex wingtips. The fuselage itself was lengthened—first by 7 feet, then by another 4—and the vertical stabilizer was moved. The result would be a 3,500-pound increase in weight. In May 1954, the Air Force approved further redesign, including a lighter canopy with better visibility and new engine-intake ducts. By now, there was also some good news: The 16,000-pound-thrust Pratt & Whitney J57-P-23 engine was going to be available.

The first of four Model 8-90 aircraft with the Area Ruled fuselage rolled out at San Diego late in 1954. Apparently the program was no longer "shrouded in secrecy." (Convair via Author's collection)

As a trainer variant of the F-102A, Convair developed the TF-102A (Model 8-12). Side-by-side seating was used in an effort to avoid lengthening the fuselage. The increased width, however, created aerodynamic problems for the new forward fuselage "tub." (Convair via Author's collection)

Through it all, and despite the slipped schedule, the Air Force remained committed to the program. In March Convair received a production contract for 37 F-102A aircraft to be delivered with the Coke-bottle fuselage between February and July of the following year. In June, the Air Force added orders for another 108 aircraft to be delivered in the last half of 1956, although these funds were informally frozen until the aircraft met strict general operational requirements issued on 4 November 1954. These stipulated an operational altitude of 54,000 feet, a 375-mile combat radius, and a speed of Mach 1.23 at 35,000 feet.

Inside the TF-102A cockpit preparing for a 1957 San Diego–to–Los Angeles flight are Gen. C. S. "Bill" Irvine, Air Force deputy chief of staff for materiel (white helmet), and Maj. Don Butterfield. Butterfield was the chief of Air Force flight acceptance, assigned to Convair's facility at Air Force Plant 42 in Palmdale, where Delta Daggers were officially delivered and accepted. Watching from the ladder is E. J. Huntsman, Convair's general foreman at the Field Operations Center at Lindbergh Field in San Diego. (Convair via Author's collection)

Convair also remained committed to the project, and its personnel demonstrated a true can-do attitude. Frank Signorelli, a structural engineer who worked on the F-102 program, recalled this in our 1994 interview:

> *"I was a young kid just out of college when I first came to work for Convair in 1950," he said. "They had a number of elderly guys—they were in their forties—who were very, very knowledgeable. Tough, cantankerous old devils, but once they got to know you, they treated you wonderfully well. They'd take you off to the side and explain things to you.*
>
> *"I worked for a fellow named John Bergstrom. He'd say, 'Frank, I've got a job for you to do. Go design it. Got it designed? Good, now go get the drawing released. Got it released? Good, go to planning and get it planned. Got it planned? Good, go get the parts made. Got the parts? Go into the factory and get the parts assembled and made into the final vehicle.'*
>
> *"When I got done, he'd send me to Edwards AFB to flight-test it. So I had the opportunity to see just about all the [facets] of designing and building an aircraft, through the flight-testing of it, which very few folks had the opportunity to do.*
>
> *"We'd do all the engineering and the designer would also build the first one. I'd go out there with changes on the back of an envelope, scratched up. I'd get one of the foremen and tell him what I'd want done, and he'd go do it. We had a team that really worked well. I could go out there with almost anything and get it done."*

The design changes, as well as numerous weight-reducing features, were combined into four redesigned YF-102A aircraft that were hand-made with the Coke-bottle fuselage and a "Case X" wing that had cambered tips and leading edges. The first of these, tail number 53-1787, was initially flown on 19 December 1954 (some sources say 20 December). As predicted, the Area Rule was accurate. This aircraft was flown at Mach 1.22 and at an altitude of 53,000 feet, earning it the nickname "Hot Rod," and an unfreezing of the previously frozen funds early in 1955. By this time, test flights had topped 55,000 feet.

Also unfrozen was the TF-102A trainer program. As the bugs were beginning to be wrung out of the YF-102A during 1954, Convair had been developing the trainer designed with side-by-side seating for instructor and student, rather than the conventional tandem configuration. Developed in Fort Worth, rather than San Diego where the aircraft were built, this concept was proposed because engineers decided that widening the fuselage would incur less of a weight and performance penalty than lengthening it.

A firm order for 20 TF-102As was placed in July 1954 following approval of the side-by-side concept, and the mock-up was inspected in September. After the first successful flight of the Coke-bottle YF-102A, an additional 28 TF-102As (also with the Coke-bottle fuselage, of

course) were added to the order list early in 1955. The first flight of the trainer occurred on 31 October, and the Air Force gave Convair a contract for 150 more TF-102As in December 1955.

The Hot Rod turned the corner for the YF-102A program as further flight testing found it meeting and then exceeding performance goals. Not only was it faster than the YF-102, it could take off from a shorter length of runway. By June 1955, initial flight testing concluded, and the program turned to structural and weapons testing. The YF-102 test-fired both 2-inch and 2.75-inch unguided Folding Fin Aerial Rockets (FFAR), as well as the Hughes GAR-1 Falcon air-intercept missile. On 8 July 1955, the pilot of one of the Hot Rod YF-102As greatly impressed the U.S. Air Force by unleashing a half-dozen Falcons and two-dozen rockets in less than 10 seconds.

Meanwhile, production-series F-102A aircraft were rolling off the Convair assembly line at Plant 2 in San Diego, the same factory that had built B-24s during World War II. The first of these made its debut flight on 24 June, and it was officially accepted by the Air Force only five days later.

Just as the YF-102A had experienced flight-test problems due to design issues, so too did the TF-102A. Convair had introduced side-by-side seating to avoid lengthening the fuselage, but the broad forward fuselage proved susceptible to serious buffeting during high-speed flight. In January 1956, the U.S. Air Force ordered a halt to production while Convair sought a fix. In an attempt to correct the problem, the company installed a revised cut-down canopy, but tests in April showed that this only served to hinder visibility. Finally, in June, the buffeting was alleviated by a combination of things, including vortex generators and a larger vertical stabilizer. With this, the Air Force gave a green light to continued production, although the total number of TF-102A aircraft orders was cut from nearly 200 to just 111. The last of these would be delivered in July 1958.

Unlike aircraft designed strictly as trainers, the TF-102A was designed to be fully combat capable and, indeed, many flew operational missions—including combat missions in Southeast Asia. Operationally, the Air Force generally assigned two TF-102As to each fighter interceptor squadron equipped with F-102A interceptors.

Development of the F-102 interceptor, modifications and upgrades notwithstanding, ended with the A model. A basket of substantial changes and improvements that were originally planned to be introduced in a successor aircraft tentatively designated "F-102B" were bundled together in the F-106 program.

In 1956, Convair and the U.S. Air Force also considered an F-102C. It would have been like the F-102A, but with a more powerful Pratt & Whitney J57-P-47 engine equipped with a titanium compressor. Convair estimated that this would give the new aircraft a speed of Mach 1.33 and a 3,000-foot boost in service ceiling. Originally referred to as the F-102X, the proposal for this variant also included a 7-inch tail cone extension. In April 1957, the Air Force opted not to pursue the F-102C concept, but rather to have Convair spend its time on development of the F-106.

The official name, Delta Dagger, was assigned to the F-102A in 1957, relatively late in the program. Previously, the name Lancer had

The curves of the Area Ruled Deuce were often compared to those of Marilyn Monroe, but it was rival fifties-era Hollywood goddess Jayne Mansfield who actually made a trip out to Edwards AFB to inspect the F-102 firsthand. (Author's collection)

been suggested, but this appellation, already used for the Republic P-43 back in the late 1930s, did not meet with Air Force approval. However, the name Delta Dagger was not widely used by pilots and support crew personnel. Instead, they typically used the term Deuce, distinguishing it as the "two" in the family of Century Series fighters that were joining the Air Force inventory in the mid to late 1950s. The TF-102A, meanwhile, was nicknamed the "Tub" because of the cumbersome-appearing shape of its forward fuselage.

The others in the Century Series—so named because it began with the number 100—would include North American Aviation's F-100 Super Sabre, McDonnell's F-101 Voodoo, the canceled Republic F-103, Lockheed's F-104 Starfighter, and Republic's F-105 Thunderchief, also known by its Vietnam-era nickname, the "Thud." The Century Series continued with the Deuce's younger brother, the F-106 Delta Dart, and two North American Aviation fighters that never reached service, the unnamed F-107 (of which three were built

The ejection seat for the F-102 was evaluated as part of* Project SMART *(Supersonic Military Air Research Track). Testing was conducted at the Air Research & Development Command's Hurricane Mesa Test Facility near Zion National Park in Utah, which was built on a table-flat mesa where ejection seats could be fired from test sleds and their parachuting pilot test dummies could descend to the valley below. Then one of the world's most advanced rocket-sled test tracks, SMART was created by the Coleman Engineering Company of Los Angeles in 1954 and consisted of two continuous 12,000-foot rails with a 56-inch gauge monitored by numerous camera stations, oscillographs, and tape recorders. (Author's collection)

and flown) and the stillborn F-108 Rapier (which never made it past the mock-up stage). The Ryan F-109, like the F-108, also never even reached the prototype stage. The F-109 designation was apparently never officially assigned, but it has been associated informally with several aircraft, including the Bell Model D-188A Mach 2 V/STOL fighter, and as a provisional designation for the McDonnell aircraft that became the F-101B. In his book, *U.S. Military Aircraft Designations and Serials*, John Andrade states that the designation was allocated to a VTOL interceptor version of the Ryan X-13, and that the tail numbers 59-2109 and 60-2715 were assigned to the aircraft. The McDonnell F-110 was the original USAF designation for its newly acquired Navy F-4 Phantom, while the F-111 was produced by Convair's parent company, General Dynamics at Fort Worth.

With acceptable F-102As in the pipeline early in 1955, and with the need for a Mach 1-plus interceptor underscored by a rapidly growing Soviet bomber fleet, the Air Force eagerly placed substantial production orders for its long-awaited 1954 Interceptor. In fact, the term 1954 Interceptor was no longer used, given that 1954 had already come and gone. The next-generation interceptor after the F-102A was referred to as the Ultimate Interceptor. No date was attached to this program, which would evolve as the Convair F-106A.

The fourth F-102A production order, placed in November 1955, called for 562 aircraft; an additional and final contract issued 10 months later added 140. Also in November 1955, the Air Force ordered its first 17 F-102Bs (later F-106A). With the 111 TF-102As, this brought the total of all members of the F-102 family to exactly 1,000 aircraft. The idea in 1951 had been to order relatively few F-102As and wait for the F-102B, but by 1955, the need for interceptors was great, so F-102As entered the inventory in larger numbers. Later, the Air Defense Command would plan for a thousand F-102Bs, but settled for far fewer F-106As.

The Air Force calculated the flyaway cost of each F-102A aircraft to be approximately $1.2 million (about $8.6 million in current dollars). Of the total, about 65 percent was the cost of the airframe, 18 percent represented the cost of the armament, about 17.5 percent went to the engine, and the balance went to electronics and other components. For the TF-102A, the flyaway cost was $1.5 million, with 76 percent being for the airframe, 12 percent for armament, and 10

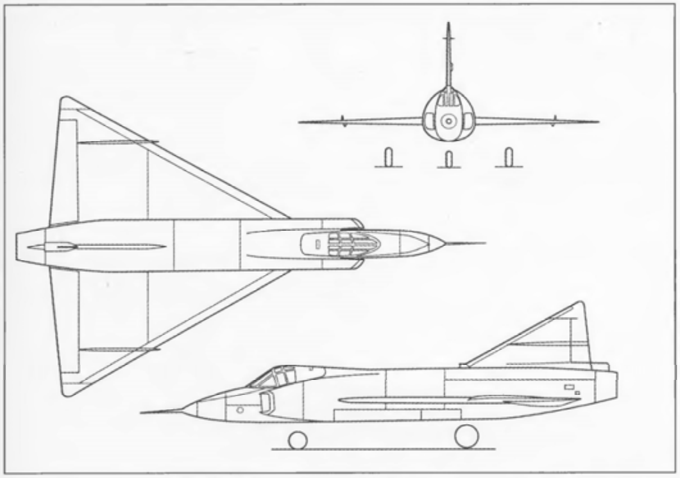
Delta wings for F-102As take shape on Convair's subassembly line at Lindbergh Field. (Author's collection)

percent for the engine. The large proportion given to armament is attributable to the fact that the U.S. Air Force considered the aircraft as a system, and therefore the armament was an integral part of the overall program.

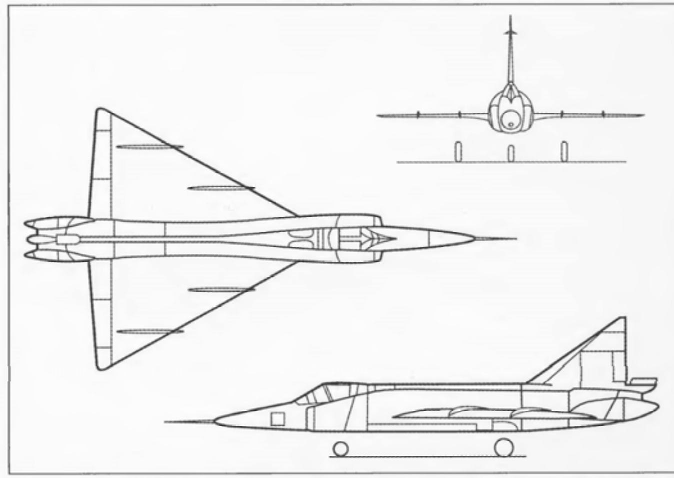
The second YF-102 (52-7995) now wearing USAF F-102 buzz number and yellow NACA tail band, shown on Rogers Dry Lake at Edwards AFB while assigned to the NACA High Speed Flight Station in 1955. The area shown behind the aircraft is now home to NASA's Dryden Flight Research Facility. This airplane was used to test wing fences for the F-102A to alleviate spanwise airflow problems, which caused pitch-ups during certain flight maneuvers. (NASA via Dennis R. Jenkins via Terry Panopalis)

The rotating assembly fixture allowed for easy installation of wiring and other accessories in the F-102A cockpit area. Because the entire nose section could be revolved horizontally, assemblers had easy access to any part of the aircraft's forward section. The greater accessibility made possible by this fixture resulted in considerable savings in installation and assembly time. (Convair via Author's collection)

Following in Jayne Mansfield's footsteps, at least for the moment, was teenager Linda Lower, crowned as "Miss Convair Management." Her father, Bill Zimmerman, worked at the company's Palmdale facility. Little could anyone have imagined back in those days that women pilots would be flying actual combat missions in jet fighters built by Convair's successor company less than fifty years after this photo was taken. (Convair via Author's collection)



Three-view drawing of the YF-102 showing its barrel-like non-Area-Rule fuselage to best advantage. Compare this aircraft's profile and plan view with the radical shape of the stubby Lippisch DM-1 prototype pictured on pages 12 and 13. (U.S. Air Force)



Three-view drawing of the production configuration F-102A. By comparison, note the Coke-bottle shape of the Area-Ruled fuselage, which gave the aircraft its true supersonic capability. (U.S. Air Force)

Precision work inside what will soon be the center fuselage of an F-102A. (Author's collection)

A veritable forest of F-102A nose cones gives the appearance of some sort of surreal fantasyland. (Author's collection)

The busy F-102A assembly line in San Diego is seen in 1957 as some of the 92 aircraft of Production Block 60 were moving through. The tail numbers represent Convair internal manufacturing ship numbers. More than half of the Delta Dagger family was yet to come. (Author's collection)

These Delta Daggers, seen on the floor in San Diego in 1958, were part of 76 aircraft delivered as part of Block 90 production, the second to the last of 23 total F-102A production blocks. (Author's collection)

Because of San Diego's mild climate, final work on the assembled aircraft could be done outdoors. This scene includes Block 60 F-102As shown with a few Block 30 TF-102A trainers mixed in for good measure. (Convair via Author's collection)

FISCAL YEAR USAF ACCEPTANCE RATES FOR OPERATIONAL DELTA DAGGERS

	YF-102	YF-102A	F-102A	TF-102A
1954	2			
1955	8	4	1	0
1956	—	—	45	3
1957	—	—	372	27
1958	—	—	427	76
1959	—	—	30	5

The thousands of precision tools used by Convair in F-102A production were works of art themselves. Unfortunately, many had to be scrapped during the early days of production because of critical design changes. (Author's collection)

DEPLOYING THE F-102 DELTA DAGGER

"Freedom has a new sound," Convair announced in this 1955 advertisement. That new sound was the screaming roar of Pratt & Whitney J57 turbojets that would soon put armed fleets of F-102As between tranquil small towns along America's northern tier and the threatening masses of Soviet bombers that were everyone's worst nightmare. (Author's collection)

The year 1954 had been linked to the F-102 a half decade earlier, marking a critical turning point, and one that underscored the need for a 1954 Interceptor from the viewpoint of those who used it. Industry journals do not typically jolt their readers with sensational, bombshell articles. But there are always exceptions. In the 15 February 1954 issue of *Aviation Week*, David A. Anderson described the Soviet Union's "Sunday Punch," an assortment of bombers capable of delivering nuclear weapons at intercontinental ranges. Though much of what the Soviet Union was doing had been monitored by Western intelligence, the article brought fear to the front page. The ominous phrase nuclear Pearl Harbor kept coming to mind.

By the early 1950s, both sides were building large numbers of long-range bombers. The Air Force had ordered large numbers of Boeing B-47s for its Strategic Air Command to be built at a pace unmatched by any Western strategic bomber production program outside of World War II. The Strategic Air Command was about to receive the first Boeing B-52s, the bomber that would be the symbol of its global reach.

The Soviet Union's Dal'naya Aviatsiya (Long Range Aviation), the counterpart to the Strategic Air Command, was meanwhile receiving the very long range Tupolev Tu-95 turboprop, NATO code named "Bear," and had apparently matched the B-52 with the Myasishchev M-4, known as Molot (hammer), but given the NATO reporting name Bison. Much overrated at the time, the Bison was known as the "Red B-52," although its capabilities were far less, and it was to be produced in much smaller numbers. Nevertheless, the M-4 became the symbol of the capability to attack the United States and Canadian industrial heartland, as the Allies had the capability to attack the industrial heartlands of the Axis in World War II.

In the *Naval War College Review* in 1999, Capt. Joseph F. Bouchard recalled that "the Cold War took a serious turn for the worse in 1954. During the early postwar years, the United States had been able to rely on superior military technology, particularly its sole possession of nuclear weapons, to counter the huge Soviet armies threatening Western Europe. The United States possessed an arsenal of long-range bombers and carrier-based naval aircraft capable of delivering nuclear weapons against the Soviet Union. The Soviets had exploded their first atomic device in 1949, but they lacked credible delivery systems to threaten the United States directly. In 1954, however, American superiority in delivery systems appeared to disappear almost overnight."

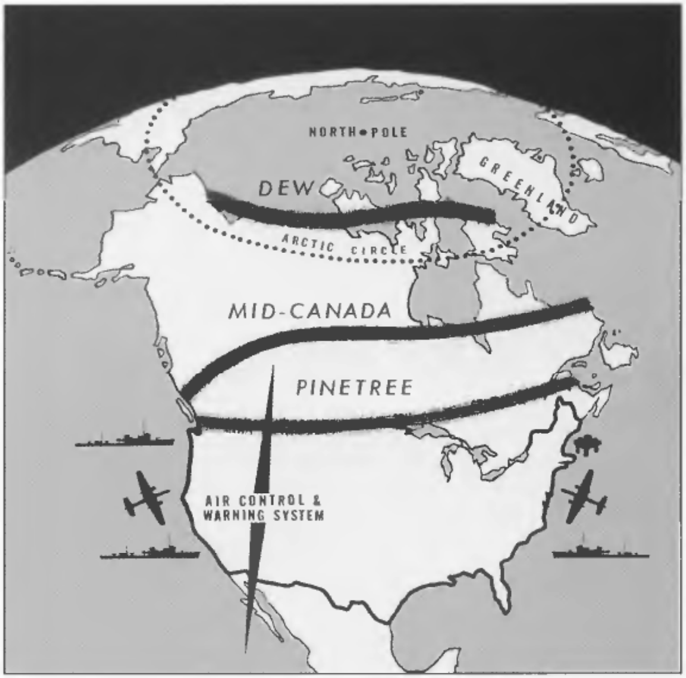
Soon after the *Aviation Week* article received such broad notice, there was talk of a Soviet superiority in long-range strategic air power that was called the "bomber gap." The U.S. Air Force response was to accelerate production of B-52s and expand air defense.

The latter was the context into which the F-102A fit but, like the WS-201A concept (in which the airplane was part of a system), interceptors were just an element in mid 1950s air defense. A large and highly visible part of the program would be the radar systems that would provide the interceptors with their targets.

In 1951, the Air Force had initiated *Project Lincoln,* a study of air defense technology headed by the Massachusetts Institute of Technology's Lincoln Laboratory, which had been the nucleus of radar development during World War II. *Lincoln*'s recommendations for a comprehensive radar system were embraced by incoming President Dwight Eisenhower in 1953 as *Project 572,* better known as the Distant Early Warning (DEW) Line of high-arctic radar stations. Built across Alaska in 1953, the DEW Line was extended along the 69th parallel through northern Canada and declared fully operational in 1957.

The DEW Line was, however, merely the northernmost of three radar lines. There was also the Pine Tree Line that ran along the United States–Canada border from Vancouver Island to the Great Lakes, and across Canada to Newfoundland. A third line, the Mid-Canada Line, that ran between the Pine Tree and DEW Lines was technically a microwave fence rather than radar, because the Canadians could not afford radar.

These lines would, in turn, provide intercept information to American and Canadian interceptor squadrons. In 1958, the United States and Canada formed the joint North American Air Defense Command (NORAD) to coordinate the warning, control, and intercept functions of both radar and interceptor elements.



The three primary and most critical lines of radar defense for American and Canadian population centers are shown here. Beginning with the Distant Early Warning, or Defense & Early Warning (DEW) Line, this intricate network of radar stations was intended to track Soviet bombers coming across the North Pole so they could be intercepted by F-102 Delta Daggers before ever reaching the United States. (Author's collection)

As the operational aircraft intended to be the Air Force's 1954 Interceptor finally reached service with the Air Defense Command two years behind schedule, it was against a backdrop of an increasingly chilly Cold War, and an increasingly complex defensive effort.

Into the fall and winter of 1955, more F-102As were accepted and flight-tested and, by April 1956, they were ready to enter operational service. The first unit to go active with the F-102A was the Air Defense Command's 327th Fighter Interceptor Squadron at George AFB, near Victorville, California. On 1 May 1956, Lt. Col. Charles Rigney, commander of the 327th, climbed into an F-102A at Convair's Palmdale flight-test center and flew it across the Antelope Valley for the short trek to George AFB. Also at George, another squadron, the 329th, became operational with the F-102A two years later. It was nearly three years behind the original schedule articulated in 1951, but the 1954 Interceptor was finally in service.

Other Air Defense Command units that became operational with the F-102A during 1956 included the 2nd and 5th Fighter Interceptor Squadrons at Suffolk County AFB in New York, the 11th Fighter Interceptor Squadron at Duluth Airport in Minnesota, the 31st Fighter Interceptor Squadron at Wurtsmith AFB in Michigan, the 323rd Fighter Interceptor Squadron at Truax Field in Wisconsin, and the 482nd Fighter Interceptor Squadron at Seymour Johnson AFB in North Carolina.

A variety of weapons had been considered for the F-102A but, after operational deployment, the Air Force decided to simplify the armament to the GAR-1, GAR-1B infrared-guided Falcon, and the 2.75-inch "Mighty Mouse" FFAR, omitting the T-214 2-inch FFAR. The stated reason was to "simplify logistical support" of the F-102A. Since Convair had been contracted to deliver the F-102As with accommodations for T-214s, these had to be converted to standard 2.75-inch FFARs in the field by the U.S. Air Force. Teams from the Air Force San Antonio Air Materiel Area at Kelly AFB accomplished the task on an estimated 170 F-102s.

Beginning in 1961, TF-102A flight training activities centered at Perrin AFB in Texas, where the 4780th Air Defense Wing (Training) generated an average of about 10 F-102A pilots monthly.

Block 30 F-102As at Convair's field location at Air Force Plant 42 in Palmdale, California. It was here that they were officially turned over to the U.S. Air Force. (Author's collection)

A typically sunny day on the flight line at Air Force Plant 42 in Palmdale, California. Convair pilots flew the F-102As here to perform their pre-delivery functional check flights (FCFs) after which Air Force pilots flew the new aircraft home to their respective squadrons. (Author's collection)

Official shield of the Air Defense Command (ADC) shows the U.S. eagle flying over North America, armed with a red lightning bolt symbolic of its aerial might. Formed as part of the U.S. Army Air Forces in 1946 and later part of the U.S. Air Force after that service was formed in 1947, the ADC was tasked with all fighter-interceptor operations during the Cold War. Disbanded in 1979, the Command's dedicated mission was then dispersed to other Air Force organizations such as the Tactical Air Command. (U.S. Air Force via Author's collection)

After receiving finishing touches and final maintenance tweaks, this Block 35 F-102A Delta Dagger will become the official property of the U.S. Air Force. (Author's collection)

In addition to the 4780th, another non-combat unit within the Air Force to operate the Delta Dagger was the 6520th Test Group for systems testing activities. The group was based at Hanscom AFB in Massachusetts, then the home of the Air Force Cambridge Research Laboratory (then AFCRL; now AFRL) and the Air Force Electronic Systems Division (now Electronic Systems Center), both components of the Air Force Systems Command (AFSC), whose functions were absorbed by the Air Force Materiel Command in 1992.

It should be pointed out here that at no time were guns seriously contemplated to be included as part of the F-102A design. This was the era when planners had decided that guns should henceforth be deleted from fighter designs, as old-fashioned dogfights were a thing of the past. A decade later, this would be proven very wrong in Vietnam, but that was an experience yet to come.

The Air Force did, however, give consideration to equipping the F-102 with the Douglas MB-1 Genie, an unguided air-to-air missile with a 1.7-kiloton W25 nuclear warhead. It was unguided because it needed no guidance. Put one round anywhere inside an enemy bomber formation and they were all toast. An inert Genie was test fired from a YF-102 in May 1956, but early in 1957 the Air Force decided against using it with operational F-102As because retrofitting the aircraft was seen as involving unacceptable production delays and this project was given up in early 1957. The Genie was, however, acquired to equip Air Defense Command F-89 Scorpions, F-101B Voodoos, and, later, Convair F-106 Delta Darts.

During 1957, despite its operational status, the F-102A continued to be upgraded and modified on the assembly line and in the field to correct various imperfections and defects. Speed-brake failures in flight were one problem that was corrected, as were landing-gear failures. The latter were corrected by new strut-metering pins and modification of the side-brace-boss bearing of the landing gear.

Two F-102As at home with the 327th Fighter Interceptor Squadron at George AFB, California, in May 1957. A year earlier, the 327th had been the first Air Defense Command squadron to receive operational Delta Daggers. (U.S. Air Force via David Menard)

A new Case 20 wing was phased into production after October 1957 after a little more than half of the F-102As had been built. This, the final major structural change, is said to have raised the combat ceiling from about 45,000 to 55,000 feet, while boosting the maximum speed at 50,000 feet to Mach 1. The Case 20 wing is also credited with greatly improving the aircraft's maneuverability, as well as its stability at low speeds.

Development time had been long for the F-102A, but production and deployment was quick. Only 45 operational aircraft were accepted in Fiscal Year 1956, but acceptances averaged 400 annually for the next two years. In the month of June 1956 alone, the U.S. Air Force accepted 51 aircraft.

The last F-102A was delivered to the Air Force in the fall of 1958, making it the most abundant interceptor in the inventory. By the end of the year, they numbered 627, or about half of the total Air Defense Command inventory of interceptors. Of the 889 F-102As accepted, 14 had been test aircraft and 875 were assigned to operational units. Most served with the Air Defense Command, but many were assigned overseas to the Pacific Air Forces (PACAF) and the U.S. Air Forces in Europe (USAFE).

Air Defense Command Fighter Interceptor Squadrons that received the F-102A during 1957 and 1958 were primarily—albeit not all—along the northern tier of the United States in the shadow of the Pine Tree Line. They included the 18th at Wurtsmith AFB in Michigan, the 27th at Griffiss AFB in New York, the 37th at Ethan Allen AFB in Vermont, the 47th at Niagara Falls AFB in New York, the 48th at Langley AFB in Virginia, the 61st and 323rd at Truax Field in Wisconsin, the 64th, 317th, and 318th at McChord AFB in Washington, the 71st at Selfridge AFB in Michigan, the 82nd at Travis AFB in California, the 86th at Youngstown in Ohio, the 87th at Lockbourne AFB in Ohio, the 95th at Andrews AFB in Maryland, the 326th at Richards-Gebaur AFB in Missouri, the 332nd at McGuire AFB in New Jersey, the 438th at Kincheloe AFB in Michigan, the 456th at Castle AFB in California, the 460th at Portland Airport in Oregon, and the 498th at Geiger Field in Washington.

In 1957, the Air Force began moving F-102As to the front lines of the Cold War. The F-102A-equipped 31st Fighter Interceptor Squadron was transferred from Wurtsmith AFB in Michigan to the Alaskan Air Command at Elmendorf AFB near Anchorage. This placed them in a position to be able to intercept the feared "Red Tide" of Soviet bombers before they penetrated too deeply into North America.

In 1958, the 317th Fighter Interceptor Squadron moved from McChord AFB to Elmendorf AFB with F-102As. The 317th would have the distinction of having more F-102As assigned at one time—46 aircraft—than any other F-102A unit ever. The 317th is also credited with numerous intercepts (not involving deadly force) of Soviet bombers probing the airspace of the Alaskan Air Defense Identification Zone (ADIZ).

In June 1958, the 327th Fighter Interceptor Squadron, the first U.S. Air Force F-102A unit, was redeployed to Thule AB in northern Greenland, at the opposite end of the DEW Line.

Also during 1957, Fighter Interceptor Squadrons at three Pacific Air Forces (PACAF) bases in Japan received the F-102A. These included the 4th at Misawa AB, the 40th at Yokota AB, and the 68th at Itazuke AB. The PACAF 16th Fighter Interceptor Squadron at Naha AB on Okinawa received the F-102A in 1959. This placed the interceptors within minutes of being able to attack waves of Tupolev M-4s that might be part of a Soviet or Chinese attempt at aggression against South Korea or Japan.

Meanwhile, the U.S. Air Forces in Europe (USAFE) became the fourth major command of the Air Force to be operational with Delta Daggers, when the 525th Fighter Interceptor Squadron at Bitburg AB in Germany received them. The following year, five additional fighter interceptor squadrons in Europe received the F-102A. These were the 32nd at Soesterberg AB in the Netherlands, 431st at Zaragosa AB in Spain, the 496th at Hahn AB in Germany, the 497th at Torrejón AB in Spain, and the 526th at Ramstein AB in Germany.

One European country that hosted U.S. Air Force F-102As was outside USAFE's sphere of operations. The "Black Knights" of the 57th Fighter Interceptor Squadron, who took up residence at Keflavik AB in Iceland in 1962, were under the Air Defense Command (Aerospace Defense Command after January 1968). During the unit's 11 years of F-102A operations at the base, its aircraft made numerous intercepts of Soviet long-range aircraft, mainly Tupolev Tu-95 Bear long-range turboprop bombers. The Bears were on patrols of their own during these years, testing and probing NATO air defenses in the air corridor known as the Greenland-Iceland-United Kingdom (GIUK) Gap.

Beginning in 1960, F-102As were also assigned to Air National Guard fighter interceptor squadrons around the United States. Those receiving the aircraft in 1960 and 1961 included the 122nd of the Louisiana Air National Guard at NAS New Orleans, the 146th of the Pennsylvania Air National Guard at Pittsburgh Airport, the 159th of the Florida Air National Guard at Thomas Cole Imeson Airport (later at Jacksonville International Airport), the 175th of the South Dakota Air National Guard at Sioux Falls Municipal Airport, the 182nd of the Texas Air National Guard at Kelly AFB, and the 199th of the Hawaii Air National Guard at Hickam AFB. Also on the list was the 111th Fighter Interceptor Squadron of the Texas Guard at Ellington Air National Guard Station, which is the Air Guard unit to which future President George W. Bush was assigned from 1968 to 1972.

Test pilot Robert Lawrence poses with the weapons that armed the F-102A Delta Dagger. He is holding a 2.75-inch "Mighty Mouse" Folding Fin Aerial Rocket (FFAR). In the foreground is a Hughes GAR-1 Falcon air-to-air guided missile. (Convair via Author's collection)

A Hughes technician adds scale to this graphic image of the hundreds of pounds of electronics that went into making the F-102A a cutting-edge interceptor. (Convair via Author's collection)

When this open house took place at George AFB in 1965, the 327th Fighter Interceptor Squadron had been operating F-102As for nine years. (J. McCann via David Menard)

More of a Hughes Aircraft display than a Convair display despite the F-102A, this December 1957 photo illustrates the fact that the airframe was only a part of a larger weapons system that included the Hughes electronics package and the Hughes GAR-1 Falcon air-to-air missile. (Convair via Author's collection)

OPERATIONAL DELTA DAGGER INTERCEPTOR SQUADRONS

2nd Fighter Interceptor Squadron "Unicorns," aka "Horny Horses" (ADC)
Suffolk County AFB, New York, 1956–1959

4th Fighter Interceptor Squadron (PACAF)
Misawa AB, Japan, 1957–1965

5th Fighter Interceptor Squadron "Spittin' Kittens" (ADC)
Suffolk County AFB, New York, 1956–1960

11th Fighter Interceptor Squadron (ADC)
Duluth, Minnesota, 1956–1960

16th Fighter Interceptor Squadron "Tigers" (PACAF)
Naha AB, Okinawa, 1959–1964

18th Fighter Interceptor Squadron (ADC)
Wurtsmith AFB, Michigan 1957–1960

27th Fighter Interceptor Squadron "Eagles" (ADC)
Griffiss AFB, New York, 1957–1959

31st Fighter Interceptor Squadron
Wurtsmith AFB, Michigan, 1956–1957 (ADC)
Elmendorf AFB, Alaska, 1957–1958 (Alaskan Air Command)

32nd Fighter Interceptor Squadron "Wolfhounds" (USAFE)
Soesterberg AB, Netherlands, 1960–1969

37th Fighter Interceptor Squadron (ADC)
Ethan Allen AFB, Vermont, 1957–1960

40th Fighter Interceptor Squadron (PACAF)
Yokota AB, Japan, 1957–1965

47th Fighter Interceptor Squadron (ADC)
Niagara Falls Airport, New York, 1958–1960

48th Fighter Interceptor Squadron (ADC)
Langley AFB, Virginia, 1957–1960

57th Fighter Interceptor Squadron "Black Knights" (ADC)
Keflavik AB, Iceland, 1962–1973

59th Fighter Interceptor Squadron "Lions," aka "Black Bats" (ADC)
Goose Bay, Labrador, 1960–1966

61st Fighter Interceptor Squadron (ADC)
Truax Field, Wisconsin, 1957–1960

64th Fighter Interceptor Squadron "Scorpions"
McChord AFB, Washington, 1960–1966 (ADC)
Paine Field, Washington, 1960–1966 (ADC)
Clark AB, Philippines, 1966–1969 (PACAF)

68th Fighter Interceptor Squadron (PACAF)
Itazuke AB, Japan, 1957–1965

71st Fighter Interceptor Squadron (ADC)
Selfridge AFB, Michigan, 1958–1960

76th Fighter Interceptor Squadron (ADC)
Westover AFB, Massachusetts, 1961–1963

82nd Fighter Interceptor Squadron
Travis AFB, California, 1957–1966 (ADC)
Naha AB, Okinawa, 1966–1971 (PACAF)

86th Fighter Interceptor Squadron (ADC)
Youngstown Airport, Ohio, 1957–1960

87th Fighter Interceptor Squadron (ADC)
Lockbourne AFB, Ohio, 1958–1960

95th Fighter Interceptor Squadron "Mr. Bones" (ADC)
Andrews AFB, Maryland, 1958–1959

102nd Fighter Interceptor Squadron (New York ANG)
Suffolk Airport, 1972–1975

111th Fighter Interceptor Squadron (Texas ANG)
Ellington ANGS, 1960–1975

114 Pterix (Wing) (Elliniki Polimiki Aeroporia)
Tanagra AB, Greece, 1969–1979

116th Fighter Interceptor Squadron (Washington ANG)
Geiger Field, 1965–1969

118th Fighter Interceptor Squadron "Flying Yankees" (Connecticut ANG)
Bradley ANGS, 1966–1971

OPERATIONAL DELTA DAGGER INTERCEPTOR SQUADRONS Continued

122nd Fighter Interceptor Squadron "Coonass Militia" (Louisiana ANG)
NAS New Orleans, 1960–1971

123rd Fighter Interceptor Squadron "Redhawks" (Oregon ANG)
Portland International Airport, 1966–1971

132nd Fighter Interceptor Squadron (Maine ANG)
Bangor, 1969–1970

134th Fighter Interceptor Squadron "Green Mountain Boys" (Vermont ANG)
Burlington International Airport, 1965–1975

142 Filo (Squadron) (Türk Hava Kuvvetleri)
Murted AB, Turkey, 1968–1979

146th Fighter Interceptor Squadron (Pennsylvania ANG)
Pittsburgh Airport, 1961–1975

151st Fighter Interceptor Squadron (Tennessee ANG)
McGhee-Tyson Airport, 1963–1964

152nd Fighter Interceptor Squadron (Arizona ANG)
Tucson International Airport, 1966–1969

157th Fighter Interceptor Squadron "Swamp Foxes" (South Carolina ANG)
MacEntire ANGB, 1963–1975

159th Fighter Interceptor Squadron (Florida ANG)
Thomas Cole Imeson Airport, 1960–1968
Jacksonville International Airport, 1968–1974

175th Fighter Interceptor Squadron "Lobos" (South Dakota ANG)
Sioux Falls Municipal Airport, 1960–1970

176th Fighter Interceptor Squadron "Raggedy Ass Militia" (Wisconsin ANG)
Truax Field, 1966–1974

178th Fighter Interceptor Squadron "Happy Hooligans" (North Dakota ANG)
Hector Field, 1966–1969

179th Fighter Interceptor Squadron (Minnesota ANG)
Duluth Municipal Airport, 1966–1971

182 Filo (Squadron) (Türk Hava Kuvvetleri)
Diyarbakir AB, Turkey, 1968–1979

182nd Fighter Interceptor Squadron (Texas ANG)
Kelly AFB, 1960–1969

186th Fighter Interceptor Squadron (Montana ANG)
Great Falls International Airport, 1966–1972

190th Fighter Interceptor Squadron (Idaho ANG)
Boise Air Terminal, 1964–1975

194th Fighter Interceptor Squadron (California ANG)
Fresno Air Terminal, 1964–1974

196th Fighter Interceptor Squadron (California ANG)
Ontario International Airport, 1965–1975

199th Fighter Interceptor Squadron (Hawaii ANG)
Hickam AFB, 1960–1977

317th Fighter Interceptor Squadron
McChord AFB, Washington, 1957–1958 (ADC)
Elmendorf AFB, Alaska, 1958–1970 (Alaskan Air Command)

318th Fighter Interceptor Squadron (ADC)
McChord AFB, Washington, 1957–1960

323rd Fighter Interceptor Squadron (ADC)
Truax Field, Wisconsin, 1956–1957
Harmon AB, Newfoundland, 1957–1960

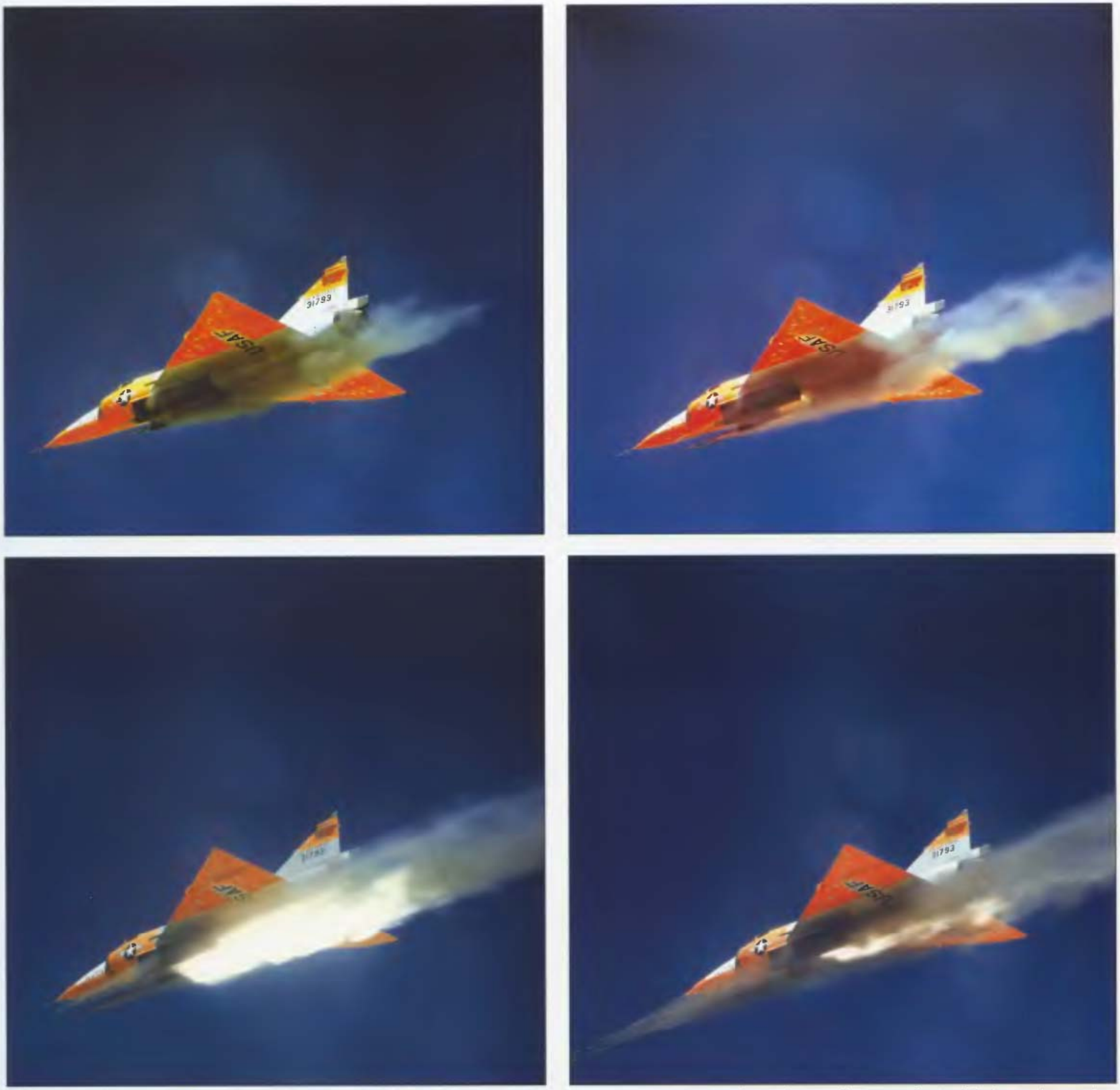
325th Fighter Interceptor Squadron (ADC)
Truax Field, Wisconsin, 1957–1966

326th Fighter Interceptor Squadron "Skywolves" (ADC)
Richards-Gebaur AFB, Missouri, 1957–1967

327th Fighter Interceptor Squadron (ADC)
George AFB, California, 1956–1958
Thule AB, Greenland, 1958–1960

329th Fighter Interceptor Squadron (ADC)
George AFB, California, 1958–1960

331st Fighter Interceptor Squadron (ADC)
Webb AFB, Texas, 1960–1963



Marked in high-visibility orange, a Block 5 F-102A earmarked for weapons testing launches a fierce salvo of 2.75-inch Mighty Mouse Folding Fin Aerial Rockets over the White Sands Missile Range in New Mexico. (Author's collection)

A split second in the operational life of an air-defense interceptor is shown here as a Convair F-102A conducts the second of a series of live salvo firings of Hughes GAR-1 air-to-air missiles during tests over the Yuma Proving Ground on 25 August 1958.

As the F-102A weapons bay opens, a trapeze mechanism releases the Falcons. (Author's collection)

As the Falcons drop into the slipstream, their engines are ignited one at a time. (Author's collection)

The Falcons accelerate, beginning to move away from the F-102A. (Author's collection)

Rapidly gaining speed, the Falcons begin streaking toward their targets. (Author's collection)

The growing presence of F-102As within units in the southeastern United States during the early 1960s was indicative of official concern with possible "Pearl Harbors" against the American southern tier by Soviet aircraft based in Cuba. When Fidel Castro came to power in 1959, the Soviets found themselves welcome on that Caribbean island just 90 miles from Florida. After the Cuban Missile Crisis of 1962, the Soviet Union withdrew its offensive missiles from Cuba, but retained a military presence. F-102As were an important part of U.S. Air Force operations that involved patrolling the area around Cuba and keeping an eye on potentially aggressive moves by Soviet or Cuban military aircraft.

During the later 1960s, the list of states whose Air National Guard units operated the F-102A expanded to include Arizona, California, Connecticut, Idaho, Maine, Minnesota, Montana, New York, North Dakota, Oregon, Pennsylvania, South Carolina, Vermont, Washington, and Wisconsin.

As the F-102A was entering service with squadrons around the globe, it continued to be modified and upgraded with leading-edge electronic equipment. The long-awaited replacement for the Hughes MG-3 fire-control system finally arrived in the form of the MG-10. It was developed by RCA, but based on the Hughes system, and there was some disagreement at the time over who deserved credit for what.

With the new fire-control system came new weapons systems. As previously noted, the F-102A had not been earmarked as a platform for the unguided Douglas MB-1 Genie nuclear-capable rocket, but it was equipped for the Hughes GAR-1 Falcon conventional missile, so it was ready when Hughes developed the guided GAR-11 Nuclear Falcon.

Hughes had started work on a nuclear-tipped Falcon in 1956, studying both semi-active radar homing and heat-seeking guidance systems (based on GAR-1 and GAR-2 conventional missiles) under the designations GAR-5 and GAR-6. Briefly moribund, these studies were reactivated in 1959, leading to a missile designated as GAR-11 (AIM-26A after 1963) that used semi-active radar homing guidance. Beginning in 1961, more than 450 F-102As were equipped to carry this weapon, which used a sub-kiloton W54 warhead that was somewhat smaller than that of the Genie's W25. Presumably, the fact that it was guided meant that a larger warhead was unnecessary.

Between 1968 and 1974, Aerospace Defense Command and Air National Guard F-102A squadrons participated in the semi-annual William Tell competitive gunnery exercises held in the skies over Tyndall AFB in Florida. These exercises, involving the firing of air-to-air weapons in simulated combat scenarios, permitted pilots to show their stuff in competition with other pilots, and it permitted the host organization, the Aerospace Defense Command, to evaluate aircraft types in action. William Tell simulated the real thing, but it was not. For the planes and pilots of the U.S. Air Force who came and went in Florida skies during the late 1950s and early 1960s, a real wartime test was just around the corner.

OPERATIONAL DELTA DAGGER INTERCEPTOR SQUADRONS Continued

332nd Fighter Interceptor Squadron (ADC)
McGuire AFB, New Jersey, 1957–1959
England AFB, Louisiana, 1959–1960
Thule AB, Greenland, 1960–1965

431st Fighter Interceptor Squadron "Red Devils" (USAFE)
Zaragosa AB, Spain, 1960–1964

438th Fighter Interceptor Squadron (ADC)
Kincheloe AFB, Michigan, 1957–1960

456th Fighter Interceptor Squadron (ADC)
Castle AFB, California, 1958–1960

460th Fighter Interceptor Squadron (ADC)
Portland, Oregon, 1958–1966

482nd Fighter Interceptor Squadron (ADC)
Seymour Johnson AFB, North Carolina (advanced operating base at Homestead AFB, Florida), 1956–1965

496th Fighter Interceptor Squadron (USAFE)
Hahn AB, West Germany, 1960–1970

497th Fighter Interceptor Squadron (USAFE)
Torrejón AB, Spain, 1960–1963

498th Fighter Interceptor Squadron (ADC)
Geiger Field, Washington, 1957–1959

509th Fighter Interceptor Squadron (PACAF)
Clark AB, Philippines, and Tan Son Nhut AB, South Vietnam, 1959–1970

525th Fighter Interceptor Squadron "Bulldogs" (USAFE)
Bitburg AB, West Germany, 1959–1969

Notes:
(1) TF-102A flight training activities were conducted by the 4780th Air Defense Wing (Training) at Perrin AFB, Texas

(2) Delta Dagger systems testing activities were conducted by the 6520th Test Group at Hanscom AFB, Massachusetts

(3) The Air Defense Command became the Aerospace Defense Command on January 15, 1968

Air Force munitions specialists load 2.75-inch Mighty Mouse Folding Fin Aerial Rockets into the weapons bay of an F-102A at Holloman AFB in New Mexico. (Author's collection)

In 1959, the 525th Fighter Interceptor Squadron "Bulldogs" at Bitburg AB in West Germany became the first USAFE squadron to fly the F-102A. This aircraft is seen on temporary duty (TDY) at Sculthorpe, England, in 1962. (David Menard)

The 496th Fighter Interceptor Squadron, based at Hahn AB in West Germany, was the second USAFE squadron to be equipped with the F-102A. This photograph was taken in May 1960, early in the Delta Dagger's tenure with the unit. (David Menard)

The 460th Fighter Interceptor Squadron at Portland International Airport in Oregon received its F-102As in 1958. This one is seen with Deuces of other squadrons on the ramp at Tyndall AFB in November 1961. (W. M. Jefferies via David Menard)

The 59th Fighter Interceptor Squadron "Black Bats" deployed this F-102A from Goose Bay, Labrador, to Tyndall AFB in Florida in October 1961. (W. M. Jefferies via David Menard)

An Alaska Air Command F-102 Delta Dagger flying in formation with an F-89 Scorpion near 20,320-foot Mount McKinley. (Author's collection)

Seen from the side, a Convair F-102A conducts the third of a series of live, three-missile salvo firings of Hughes GAR-1 air-to-air missiles during tests over the Yuma Proving Ground on 25 August 1958.

The Falcons remained nestled within the F-102A weapons bay as the bay doors open. (Author's collection)

As the engine of the first Falcon is ignited, the others have only just begun to be released by the trapeze. (Author's collection)

The rocket engines of the three Falcons are burning now, pushing them away from the F-102A. (Author's collection)

The full salvo is already accelerating to a speed greater than that of the F-102A. (Author's collection)

The Falcon missiles that arm this 496th Fighter Interceptor Squadron Deuce are visible with the weapons bay doors open. They will be retracted into the bays before flight. (David Menard)

The "Skywolves" of the 326th Fighter Interceptor Squadron at Richards-Gebaur AFB in Missouri operated the Deuce from 1957 to 1967. (T. Love via David Menard)

Flight training for pilots transitioning to the Delta Dagger from other interceptor types was conducted by the 4780th Air Defense Wing (Training) at Perrin AFB in Texas. The unit operated both TF-102As and F-102As, such as the one seen here at Nellis AFB in September 1962. (W. M. Jefferies via David Menard)

The 331st Fighter Interceptor Squadron at Webb AFB in Texas operated the F-102A from March 1960 through May 1963. This photograph, taken in September 1962, shows the tail of the aircraft marked with the badges of both the 331st and the 199th Fighter Interceptor Squadron of the Hawaii Air National Guard, which was the last unit to operate the F-102A. (W. M. Jefferies via David Menard)

A 31st Fighter Interceptor Squadron Deuce over the vast arctic landscape of Alaska in February 1958. The 31st was based at Wurtsmith AFB, Michigan, when it received its first F-102As in 1956, but the unit was transferred to the Alaskan Air Command and to Elmendorf AFB near Anchorage the following year. (U.S. Air Force)

An Alaskan Air Command F-102A pilot and a couple of friends enjoy a dogsled outing at Elmendorf AFB. The Deuce proved itself in the cold weather of Alaska. (Convair via Author's collection)

GENERAL DYNAMICS CORPORATION'S ROLE IN NATIONAL DEFENSE

Frank Pace, Jr., president of General Dynamics Corporation (then the parent corporation of Convair) made the following comments in an impromptu address before the Convair Astronautics Management Club in February 1959:

> *"Convair men and women are among this nation's foremost contributors to the safety of the free world. We are involved in a 'chancy' business. We have to take chances to succeed. I see our efforts directed more toward competition with the USSR, which would destroy our way of life, than with other business firms. And we must pursue this problem of survival relentlessly.*
>
> *"Where we are today is important. But where we are heading is more important."*

The first F-102A to receive the Case 20 (Case XX) wing was 56-1317, seen here resplendent in high-visibility orange markings with the AFFTC at Edwards AFB on 14 October 1957. The missile bay was gutted to make way for test equipment and ballast, simulating a full weapons load. (NASA via Dennis R. Jenkins via Terry Panopalis)

Chapter Six

The F-102 Delta Dagger At War

A pair of 509th Fighter Interceptor Squadron Deuces over South Vietnam in 1967 after the introduction by PACAF of two-letter tail codes. (U.S. Air Force)

The U.S. Air Force began committing operational assets to support the soon-to-be-escalated war in Southeast Asia in 1961. Initially, the mission was in support of South Vietnam in its fight against Viet Cong guerrillas, who were, in turn, supported by North Vietnam. In the early days, the U.S. Air Force committed slow, low-flying attack aircraft such as Douglas A-1 Skyraider and World War II-vintage Douglas B-26 (formerly A-26) attack bombers, as well as armed North American Aviation T-28 trainers.

Other, more sophisticated assets were soon committed. The Thirteenth Air Force, a component of the Pacific Air Forces (PACAF) based at Clark AB in the Philippines, set up an advance headquarters (ADVON) of its Second Air Division in South Vietnam. Gradually, the air war began to escalate. Unidentified radar tracks were detected near South Vietnam air space, and it was feared that North Vietnamese air force aircraft might begin attacks against South Vietnam, United States aircraft, or both. Suddenly, there was a perceived need for interceptors.

Meanwhile, F-102As had become operational with the 509th Fighter Interceptor Squadron at Clark AB in 1959. Four F-102A Deuces were sent to South Vietnam in March 1962 on a "temporary"

A pair of F-102As on the ramp at Tan Son Nhut AB near Saigon in January 1966. Early in their deployment into the war zone, the Deuces were painted in standard USAF Air Defense Command light gray. (U.S. Air Force)

basis, beginning nearly a decade of commitment to the war zone. Under the code name Water Glass, the F-102As were based at Tan Son Nhut AB near Saigon, rotating in and out, alternating with U.S. Navy aircraft. Water Glass ended in May 1963, but the deployments were resumed six months later in an intermittent operation code named Candy Machine. During this time, F-102As operated from Tan Son Nhut, as well as from the air base at Da Nang in northern South Vietnam.

After the Gulf of Tonkin incident of August 1964, involving attacks and supposed attacks by North Vietnamese patrol boats against U.S. Navy ships near North Vietnam, the United States entered the war in a big way. With the increased U.S. Air Force commitment, larger numbers of F-102As were deployed to serve the air defense needs of American and South Vietnamese assets in the war zone. By the end of 1966, PACAF had a half-dozen F-102As on alert at both Bien Hoa AB and Da Nang AB, as well as six at Udorn RTAFB in Thailand, and four at Don Muang RTAFB, also in Thailand. The mission of the interceptors in Southeast Asia can be considered successful, at least passively, because North Vietnam never launched a major bomber attack against cities or high-value targets in South Vietnam or Thailand, even though they possessed Ilyushin Il-28 bombers capable of such attacks.

Of course, the Deuces deployed to Southeast Asia did not merely sit on the runways and wait to intercept North Vietnamese bomber attacks that never came. They flew numerous escort missions in support of PACAF fighter bombers and Strategic Air Command B-52s that were attacking enemy positions. Nor were only F-102As involved. Combat-ready, two-seat TF-102As also flew escort missions. Having a second person in the cockpit often proved to be useful.

PACAF F-102As in revetments at Danang AB in South Vietnam in July 1966. The base frequently came under attack from the Viet Cong armed with mortars, and several Deuces were lost to this type of ground fire. The revetments saved many others, however. (U.S. Air Force)

PACAF 509th Fighter Interceptor Squadron F-102s over Thailand in 1966. The 509th was one of several squadrons operating dissimilar aircraft types that were part of the 405th Tactical Fighter Wing at Clark AB, commanded by Col. Chuck Yeager from 1966 to 1968. (U.S. Air Force)

A trio of PACAF Deuces low over the countryside of South Vietnam during a mission in 1966. In addition to air defense, the F-102As also flew ground-attack missions. (U.S. Air Force)

Based at Clark AB in the Philippines, the PACAF 509th Fighter Interceptor Squadron operated routinely from this Advanced Echelon (ADVON) operating location at Don Muang RTAFB in Thailand throughout much of the war in Southeast Asia. The squadron also deployed occasionally to South Vietnam. (U.S. Air Force)

A three-ship gaggle of camouflaged Pacific Air Force (PACAF) F-102As roll into a dive for the camera ship over South Vietnam, 1966. (U.S. Air Force)

Two-seat Deuces were a rare sight in Vietnam. This TF-102 was escorting Boeing B-52 Stratofortresses flying an Operation Arc Light raid against Viet Cong hideouts 18 miles north of Saigon on 19 December 1966. (U.S. Air Force)

Inset: A pilot of the 509th Fighter Interceptor Squadron is checked out on the aerial refueling (AR) apparatus retrofitted to the F-102As in Southeast Asia. As pilot Joe Sutila described it, the pilot used the thrust of his fighter to push the probe into the basket to get the fuel flowing. After three successful practice hookups, each pilot was deemed to be AR qualified. (Photo by Joe Sutila)

An F-102A joins up on a Lockheed HC-130H Hercules over Southeast Asia. Fitted with Fulton Recovery System booms on its nose, this alleged "rescue" HC-130H was actually used to recover Firebee reconnaissance drones as they exited North Vietnam. (Photo by Joe Sutila)

A PACAF pilot dashes for his Deuce on the tarmac at Don Muang or Udorn. The F-102A's crews scrambled often, but rarely came close to intercepting North Vietnamese MiGs, and were never credited with a MiG kill. (U.S. Air Force)

Meanwhile, the Air Force studied the possibility of adapting the F-102A as a ground-attack platform. In 1965, under an experiment called *Project Stove Pipe*, a few 509th Fighter Interceptor Squadron aircraft tried attacking ground targets with their FFARs and heat-seeking Falcon missiles, but apparently without much success.

Flying out of Clark AB in the Philippines in early 1966, F-102As of the 509th Fighter Interceptor Squadron practiced refueling from Boeing KC-135 Stratotankers over the South China Sea. F-102s never refueled on operational missions, however, because all the other U.S. Air Force aircraft in the theater were configured for boom refueling rather than for using the basket. (Photo by Joe Sutila)

Convair submitted several proposals for adding external hard-points for air-to-ground weapons to the wings of F-102As, but the Air Force never showed much interest, given the large number of other aircraft—from F-100s to F-4s—then available and being used as dual-role fighter bombers.

By the end of 1969, F-102A operations in Southeast Asia officially wound down, although some 509th Fighter Interceptor Squadron aircraft remained in service at Don Muang RTAFB until July 1970. By this time, F-102A operations with both the 64th and 509th Fighter Interceptor Squadrons at Clark AB were terminated and the Deuce's career in Southeast Asia came to an end.

Between 1964 and 1969, PACAF lost a total of 15 F-102As in the war zone. Of these, most were counted as non-combat losses, although they included aircraft lost on the ground to enemy mortar attacks. Two F-102As were lost to ground fire, and one was shot down.

In retrospect, it is a bitter pill to swallow for Deuce fans to know that in its only known air-to-air combat with the U.S. Air Force, the Deuce lost. The incident occurred on 3 February 1968 as two F-102As of the 509th Fighter Interceptor Squadron were tasked with escorting electronic warfare aircraft on a mission over Laos. As the two aircraft waited for the electronic warfare aircraft to rendezvous with them, North Vietnamese MiG-21s surprised them.

1Lt. Wallace Wiggins radioed his wingman that something was wrong with his aircraft, not knowing that a Soviet-made Atoll air-to-air missile had hit him. The missile had failed to explode, but it did a great deal of damage to his F-102A just by hitting it. His wingman, Capt. Allen Lomax, fired three Falcons as the Mig-21s quickly exited the area, but failed to score a single hit. Wiggins's aircraft, meanwhile, disintegrated and he was killed in action.

This F-102A refueling system consisted of a probe on a tripod mounted externally on the fuselage. The piping ran along the fuselage, entering the aircraft forward of the vertical tail. Convair engineers designed this crude arrangement practically overnight. During flight, it created an annoying whistling noise because of wind resistance, which also degraded performance by 10 percent. (Photos by Joe Sutila)

For Wiggins, it had been a deadly surprise. For Convair and for the Air Force, the big surprise that had already developed in the skies over Southeast Asia was that contrary to what was supposed when the F-102 was designed, the era of air-to-air dogfighting was *not* over.

Farther north, beginning in 1963, PACAF also committed a small number of F-102As to the air defense of South Korea under the code name Bone Deep. Throughout the 1960s, several F-102As were deployed to the Far East to be in a position to support various contingencies that might occur on the Korean peninsula, especially the crisis surrounding the North Korean seizure of the Navy's USS *Pueblo* surveillance vessel on 22 January 1968.

One such unit, the 82nd Fighter Interceptor Squadron, is notable for having conducted the first overseas deployment of F-102As supported by aerial refueling tankers. Their arrival at Naha AB, Okinawa, in February 1966 permitted the 555th Tactical Fighter Squadron, equipped with F-4C Phantoms, to redeploy to Southeast Asia. During the *Pueblo* crisis two years later, the F-102As of the 82nd were briefly forward deployed to Osan AB in Korea. Also in 1968, the 82nd deployed F-102As to Bien Hoa AB in South Vietnam. In May 1971, the 82nd was to be the last PACAF squadron to cease operations with the Deuce.

Ground crewmen at Danang AB exchanging the antennas for the F-102A's MG-10 radar, circa 1966. One antenna can be seen on the ground; the other is inside the aircraft. (Photo by Joe Sutila)

An F-102A on the ramp at Don Muang RTAFB at Bangkok, with its missile bay doors in the open position, clearly displaying its Hughes AIM-4A Falcon radar-guided missiles. (Photo by Joe Sutila)

A detachment of 46th Fighter Interceptor Squadron Delta Daggers on the ramp at Don Muang RTAFB at Bangkok in 1966. Note the TF-102A in the foreground. The blue missile beneath the first F-102A is a "Whizzum," a Weapon System Evaluator Missile (WSEM). It was an inert missile used to test all the circuits within the launch system. The white styrofoam "caskets" on the ground contained either Whizzums or live missiles. (Photo by Joe Sutila)

This excellent side view shows an F-102A with its weapon bay doors open to reveal both the solid-orange Hughes AIM-4A Falcon radar-guided missile and the two-tone AIM-4B heat-seeking missile. Not seen are the smaller unguided Mighty Mouse FFARs carried in the missile bay doors themselves. As Joe Sutila recalls, F-102A pilots were occasionally called upon to use Mighty Mouse rockets to attack ground targets. During one several-month period, Sutila and other Deuce pilots were also ordered to conduct nocturnal attacks against enemy campfires using the heat-seeking AIM-4B. Sutila was never briefed on the effectiveness of the latter tactic. (Joe Sutila photo)

As F-102A pilot Joe Sutila waits in the slot position, two 509th Fighter Interceptor Squadron Delta Daggers light their afterburners for a formation take-off from Clark AB in the Philippines in 1966. (Joe Sutila photo)

Joe Sutila's wingman in Hawk Nest II poses for a snapshot while the two 509th Fighter Interceptor Squadron F-102As fly in close formation over South Vietnam, just west of Saigon. The little radome ahead of the canopy is actually the infrared heat seeker used to locate the exhaust of a target aircraft so the AIM-4B could attack. (Photo by Joe Sutila)

In 1966, the 82nd Fighter Interceptor Squadron became the first unit to deploy F-102As overseas supported by aerial tankers. With the support of Strategic Air Command KC-135s, the Deuces flew to Naha AB in Okinawa. Two years later, the 82nd forward deployed to Osan AB in Korea, and to Bien Hoa AB in South Vietnam. The 82nd was to be the last PACAF squadron to fly the F-102A. (U.S. Air Force)

Chapter Seven

The F-102 Delta Dagger's Later Career

In 1964, the California Air National Guard's 194th Fighter Interceptor Squadron, 144th Fighter Interceptor Group, was the first "Calguard" squadron to become operational with the F-102A. Based at Fresno in the Central Valley, the 194th deployed to Europe in 1970 under **Operation Coronet East**, *and transitioned to the F-106A in 1974.* (P. B. Lewis via David Menard)

After all those years of development, the Delta Dagger's years with the front-line Air Force squadrons were short. From 627 at the end of 1958, their numbers declined to 221 in the Air Defense Command just two-and-a-half years later, although larger numbers remained in service with PACAF and USAFE through the 1960s. Through the years, the F-102A had a generally good safety record. Even including the losses during the war in Southeast Asia, just 16 percent of the fleet, or 140 aircraft, were lost to flying accidents during 14 years of operations. According to the Air Force Safety Center, a total of 259 aircraft were lost to all causes during the Delta Dagger's service career.

By the end of 1969, only one squadron remained in the command (now the Aerospace Defense Command), the 57th Fighter Interceptor Squadron "Black Knights" at Keflavik Airport in Iceland. By the middle of 1972, only 15 F-102As and a pair of TF-102As remained in the Air Force. Their Aerospace Defense Command successors included the McDonnell F-101B—which also served as an interceptor with Canadian Forces—and the Convair F-106A, the Deuce's younger sibling.

Through the years, the Air Force often set aside a few F-102As for use in special tests of various armaments and components. These are found mentioned in various official documents as JF-102As, a temporary designation.

F-102 ANNUAL FLIGHT SAFETY STATISTICS

Last updated 23 March 2005

YEAR	NON-RATE	CLASS A		CLASS B		DESTROYED AIRCRAFT		FATALITIES		FLIGHT HOURS	
	Count	Count	Rate	Count	Rate	Count	Rate	Pilot	Total	Year	Cum
CY53	0	1	—	0	—	1	—	0	0	—	—
CY54	0	0	—	0	—	1	4,761.90	0	0	21	21
CY55	0	1	1,298.70	0	—	0	—	0	0	77	98
CY56	0	5	92.80	0	—	3	55.68	0	0	5,388	5,486
CY57	0	30	56.94	8	15.19	14	26.57	3	3	52,683	58,169
CY58	0	37	26.23	5	3.54	18	12.76	7	9	141,066	199,235
CY59	0	44	25.60	2	1.16	26	15.13	10	10	171,869	371,104
CY60	0	29	19.59	3	2.03	16	10.81	4	4	148,048	519,152
CY61	0	37	19.34	2	1.05	26	13.59	8	9	191,339	710,491
CY62	0	30	14.09	8	3.76	26	12.21	4	6	212,962	923,453
CY63	0	24	11.16	2	0.93	24	11.16	10	10	215,003	1,138,456
CY64	0	17	7.92	4	1.86	17	7.92	5	5	214,729	1,353,185
CY65	0	19	9.58	6	3.03	16	8.07	5	5	198,303	1,551,488
CY66	0	18	9.44	1	0.52	13	6.82	3	3	190,725	1,742,213
CY67	0	18	9.44	3	1.57	15	7.87	3	3	190,656	1,932,869
CY68	0	13	6.92	3	1.60	11	5.86	1	1	187,769	2,120,638
CY69	0	13	8.02	4	2.47	10	6.17	2	2	162,158	2,282,796
CY70	0	3	2.83	1	0.94	3	2.83	1	1	105,923	2,388,719
CY71	0	6	9.03	0	—	7	10.53	2	2	66,471	2,455,190
CY72	0	3	5.67	2	3.78	3	5.67	1	1	52,933	2,508,123
CY73	0	5	10.00	1	2.00	5	10.00	1	1	50,008	2,558,131
CY74	0	1	2.70	1	2.70	1	2.70	0	0	37,010	2,595,141
CY75	0	0	—	0	—	0	—	0	0	9,968	2,605,109
CY76	0	1	68.12	0	—	1	68.12	0	0	1,468	2,606,577
CY77	0	0	—	0	—	0	—	0	0	1	2,606,578
CY78	0	0	—	0	—	0	—	0	0	32	2,606,610
CY79	0	0	—	0	—	0	—	0	0	66	2,606,676
CY80	0	1	1,369.90	0	—	1	1,369.86	0	0	73	2,606,749
CY81	0	1	2,000.00	0	—	1	2,000.00	0	0	50	2,606,799
LIFETIME	0	357	13.69	56	2.15	259	9.94	70	75	2,606,799	2,606,799

Aircraft destroyed per 100,000 flight hours 9.93555698

The 196th Fighter Interceptor Squadron of the California Air National Guard, based at Ontario International Airport 50 miles east of Los Angeles, received their first Deuces from the Air Force in May 1965 and continued operating them until March 1975. (David Menard collection)

Where did the F-102s go? The answer is that many Deuces still had a future with the Air National Guard. The first seven F-102As were delivered to the Guard in 1960, and by the end of 1961, there were 130. By 1966, the Air National Guard total stood at 311 F-102As and 28 TF-102As. This number would remain relatively unchanged until the early 1970s, as the inflow of aircraft leaving Air Force squadrons was matched by the outflow of aircraft to the scrap heap or storage.

Of the Air National Guard units that received the Delta Dagger in the 1960s, most retained it until the early 1970s, although Arizona, North Dakota, and Washington converted to other types in 1969. The Air National Guards of California, Idaho, New York, Pennsylvania, South Carolina, and Vermont all kept the Deuce in service until 1975, and Hawaii kept the aircraft until 1977.

In 1968, the U.S. Air Force transferred some F-102As to two NATO countries, Turkey and Greece, under the Military Assistance program. Coincidentally, the two NATO countries to receive the aircraft are two countries that were in a virtual state of war with one another for many of the years that they operated the Deuce.

The transfer of Delta Daggers to Turkey and Greece was under a program code named *Peace Violet,* a strange appellation when the two countries involved weren't even at peace with each other. *Peace Violet* began in November 1967 when a half-dozen instructor pilots of the Turkish air force, the Türk Hava Kuvvetleri, came to Perrin AFB in Texas to learn to fly the F-102A. A similar number of Greek instructor pilots from the Hellenic Air Force (Elliniki Polimiki Aeroporia) arrived at Perrin AFB after their Turkish counterparts had left. It would have been, um, awkward to have them there at the same time.

The 190th Fighter Interceptor Squadron of the Idaho Air National Guard transitioned to the F-102A from the North American F-86L in July 1964. Based at the airport at Boise, the 190th flew the Deuce for 11 years before converting to McDonnell RF-4C Phantoms. (David Menard collection)

A tight formation of Minnesota Air National Guard Deuces is shown in flight. Based at the Duluth Municipal Airport, the 179th Fighter Interceptor Squadron operated the F-102A from 1966 to 1971 when it transitioned to McDonnell F-101Bs. (Gen. W. Gatlin via David Menard)

Air National Guard F-102s representing Idaho's 190th Fighter Interceptor Squadron, as well as Wisconsin's 176th "Raggedy Ass Militia" Fighter Interceptor Squadron. The latter was based at Truax Field (previously Truax AFB) near Madison from 1966 to 1974. The shark-faced Idaho Deuce wears Southeast Asia camouflage. (J. Michaels via David Menard)

Starting in 1968, at least three-dozen former U.S. Air Force F-102As and TF-102As were sent to Construcciones Aeronáuticas SA in Spain, where they were serviced and sent on to the Türk Hava Kuvvetleri. In turn, the Elliniki Polimiki Aeroporia received 20 F-102As and four TF-102As. The Turkish Delta Daggers were operated by 142 Filo (Squadron) at Murted and 182 Filo at Diyarbakir. In Greece, all of the Delta Daggers were operated by the Elliniki Polimiki Aeroporia 114 Pterix (Wing) at Tanagra.

Allan Magnus reports that during the 1974 Cyprus showdown, F-102s were involved in air combat with net results of one loss and one victory. On 21 July, pilot I. Dinopoulos of the Elliniki Polimiki Aeroporia, flying a Northrop F-5A, shot down a Turkish F-102. The following day, Onur Sitki of the Türk Hava Kuvvetleri's 142 Filo downed a Greek F-5 while flying the F-102A that had earlier borne the U.S. Air Force tail number 55-3401.

Both air forces phased out their Delta Daggers during 1979, with the Türk Hava Kuvvetleri transitioning to F-104Gs. Because of a temporary arms embargo imposed by the United States, Greece chose to buy French aircraft, replacing their Delta Daggers with the Dassault Mirage F-1CG.

A few of the former Greek or Turkish F-102s ended up in Riyadh, Saudi Arabia, as maintenance trainers. Noted aviation author Dennis R. Jenkins reports that when he was there in 1983, there were three such aircraft on the military side of the airport in Royal Saudi Air Force markings. "Taking pictures was a death-offense," Dennis tells. "So I never did, but it was pretty cool to look at."

In the United States, two non-military government agencies used former-U.S. Air Force Delta Daggers. The Federal Aviation Administration (FAA) used one briefly in 1970 in supersonic transport studies that were being conducted during the time that Boeing was developing its later-canceled Model 2707 jetliner. NASA, meanwhile, operated a number of F-102As, mainly as chase aircraft for various research aircraft programs.

During that time the Air Force utilized some of the retiring F-102As as target drones to supersede the ongoing Ryan BQM-34 Firebee drone program. The McDonnell Douglas F-15 Eagle was beginning to be developed and after the Vietnam experience, air-to-air combat was again a high priority in the development of fighter aircraft. In order to refine the F-15 as a fighter, it would need something to fight.

Under the *Pave Deuce* program, managed at the Armament Development & Test Center at Eglin AFB in Florida, more than 200 surplus Delta Daggers were converted as target drones. The idea was to create a flying target that would simulate the Mikoyan-Gurevich MiG-21 that was widely used by Warsaw Pact air forces and others against whom the U.S. Air Force might have to fly combat missions. Ironically, the Delta Dagger would be called upon to mimic the first aircraft type to have shot it down.

When the *Pave Deuce* program went out to bid, a number of contractors submitted proposals. These included Celesco Industries, Lear Siegler, Lockheed Aircraft, Hughes Aircraft (teamed with Honeywell), Northrop, and Sperry Rand Corporation. In April 1973, Sperry Rand received a $5.5 million contract for the modification of six F-102s into two remotely piloted aircraft. A small number of aircraft (probably fewer than 10 and possibly as few as two) that would retain controls so that a human pilot could fly them were designated as QF-102. The others had the human component deleted and were given the missile designation PQM-102A. It is a coincidence that the numeral "102" was available in the missile numbering sequence at the time that these former Delta Daggers became drones. All drones were numbered in the missile designation numbering sequence through the end of the twentieth century, although they now have "Q" as their main designation letter. The human controls were for use in contractor-operated flights.

This New York Air National Guard F-102A wears the war paint in which it flew with the Air Force in Southeast Asia. The 102nd Fighter Interceptor Squadron flew the Deuce from Suffolk County Airport (formerly Suffolk County Air Force Base and now Gabreski Field) on Long Island from 1972 to 1975. (David Menard)

The actual *Pave Deuce* conversion work was undertaken at the Sperry Flight Systems Division in Litchfield Park, near Phoenix, Arizona, and later at other locations. This involved replacing pilot controls with a flight-control stabilization system that permitted both autonomous and remote-control operations. For the latter, a radio-command guidance and telemetry system was installed, allowing tracking by radar such as the AN/FPS-16. The purpose of the PQM-102A was to serve as a target for other aircraft to shoot down. Naturally, the job of the PQM-102A was to avoid being shot down because how could the hunter hone his skills if the prey gave up easily? With this in mind, the PQM-102A carried various sensors to rate how close an offensive missile came to hitting it.

CONVAIR F-102A DELTA DAGGER (MODEL 8) SPECIFICATIONS

Dimensions
Wingspan: 38 feet 1 inch (11.6 meters)
Length: 68 feet 5 inches (20.9 meters)
Tail height: 21 feet 2.5 inches (6.5 meters)
Wing area: 695 square feet (64.6 square meters)

Weights
Empty: 19,350 pounds (8,700 kilograms)
Gross: 28,150 pounds (12,780 kilograms) (later 31,500 lbs, 14,300 kgs)
Combat: 24,494 pounds (11,100 kilograms)

Powerplant
1 Pratt & Whitney J57-P-23 turbojet engine
Rated at 16,000 pounds (7,265 kilograms) of thrust with afterburner
(Later, one P&W J57-P-25 turbojet engine rated at 17,000 pounds [7,700 kilograms] of thrust with afterburner)

Performance (with J57-P-23)
Cruising speed: 605 mph (975 kph)
Top speed: 780 mph (1,255 kph) at 35,000 feet (10,668 meters)
Rate of Climb (sea level): 17,400 feet (5,303 meters) per minute
Unrefueled ferry range: 1,492 miles (2,400 kilometers)
Combat radius: 386 miles (622 kilometers)
Service ceiling: 53,400 feet (16,287 meters)
Combat ceiling: 51,800 feet (15,800 meters)

Armament
12 2.75-inch Mighty Mouse Folding Fin Aerial Rockets (FFAR)
2 Hughes AIM-26A (formerly GAR-11) nuclear capable guided missiles
6 Hughes AIM-4 Falcon (Super Falcon from AIM-4E) guided missiles carried in pairs selected from:
AIM-4A (formerly GAR-1D) radar-homing missile
AIM-4C (formerly GAR-2A) infrared-guided missile
AIM-4D (formerly GAR-2B) infrared-guided missile
AIM-4E (formerly GAR-3) radar-homing missile
AIM-4F (formerly GAR-3A) infrared-guided missile
AIM-4G (formerly GAR-4A) infrared-guided missile

Note: The AIM-4s were carried six at a time unless AIM-26s were carried, in which case there were two AIM-26s, plus two AIM-4s.

These F-102As served with the Number 114 Pterix (Wing) of Greece's Hellenic Air Force (Elliniki Polimiki Aeroporia). Based at Tanagra AB, the Hellenic Deuces were operational through the 1970s. Also flown by Turkey's air force (Türk Hava Kuvvetleri), F-102s saw combat action on both sides during the 1974 Cyprus showdown. (David Menard collection)

The end of the line for the F-102A was as a remote-piloted target drone. Under the project code name Pave Deuce, over 200 aircraft were converted and redesignated as PQM-102s. The first Pave Deuce was delivered in 1973 and the last one was shot down in 1985. In this picture, a former California Air National Guard Pave Deuce conducts "inflight banking" over Holloman AFB, New Mexico, in 1979. The meaning of the jack-o'-lantern painted on the side is unclear. (U.S. Air Force)

N617NA (formerly U.S. Air Force 56-998) was the only F-102A to fly with NASA in civil registry. It served for many years, mainly as a chase plane, at NASA's Lewis Research Center (now Glenn Research Center) near Cleveland, Ohio. Coincidentally, an F-106A was also used by NASA at Lewis with a registration one digit lower, N616NA. Another civilian-registered Deuce (NA300) served with the FAA. (Author's collection)

A Türk Hava Kuvvetleri F 102A (53 1815) of 114 Filo (squadron) with early square-shaped national insignia, on the ramp at Murted, Turkey. Note weapon bay doors in the open position. Although several other U.S. fighter aircraft such as the F-84, F-86, and F-104 were flown by the air arms of NATO and other American allied countries, the F-102 was not widely used outside the U.S. Air Force. Its larger sibling, the F-106, along with Republic's F-105 Thunderchief, was never exported. (Jerry Geer via Terry Panopalis)

The initial PQM-102A flight came in August 1974, and the type became operational with the U.S. Air Force two months later. The conversions continued until 1982, with the initial PQM-102A drones being joined by PQM-102Bs, which were capable of operating at altitudes as low as 200 feet. It has been reported that the PQM-102B conversions could also be flown by a human pilot in their cockpit. Through the years, the Delta Dagger drones are said to have been shot down by a variety of air-to-air weapons, including the AIM-7 Sparrow and AIM-9 Sidewinder—launched by manned aircraft such as the F-15 Eagle—as well as surface-to-surface missiles from the FIM-92 Stinger to the MIM-104 Patriot. When the last PQM-102 was shot down in 1985, Sperry turned to converting surplus F-100s.

The Delta Dagger was born in the formative years of the Cold War and it served in American insignia for most of that tense and difficult period. Having been conceived as the 1954 Interceptor, it missed that target by a few years, but filled squadrons quickly after deliveries finally began. Though its career with the Air [Aerospace] Defense Command was short, the Deuce's career with active-duty Air Force and Air National Guard units spanned two decades.

The last U.S. operator of the F-102A was the 199th Fighter Interceptor Squadron of the Hawaii Air National Guard at Hickam AFB, adjacent to Honolulu International Airport. The Deuce served with the Hawaii Guard for nearly 17 years, from December 1960 to January 1977, when the 199th completed the transition to the F-4C Phantom. For most of the last seven years, after Hawaii's Army National Guard decommissioned its last Nike surface-to-air missiles in 1970, the Deuce served as the sole full-time air defense asset protecting the Aloha State and the base at Pearl Harbor—which had been the rallying call not only for the United States involvement in World War II, but for the strong postwar air defense, of which the Deuce was such an important part.

F-102A N617NA (formerly Air Force 56-0998) was used by the NASA Lewis Research Center from 1970 to 1974, primarily as a chase aircraft for a highly modified NF-106B SST test-bed. (NASA via Terry Panopalis)

CONVAIR F-102 DELTA DAGGER (MODEL 8) PRODUCTION CLOSE-UP

YF-102-CO (Model 8-80)	2	F-102A-60-CO (Model 8-10)	92	TF-102A-30-CO (Model 8-12)	8
YF-102-CO (Model 8-82)	8	F-102A-65-CO (Model 8-10)	97*	TF-102A-35-CO (Model 8-12)	1*
YF-102A-CO (Model 8-90)	4	F-102A-65-CO (Model 8-10)	4*	TF-102A-35-CO (Model 8-12)	7*
F-102A-5-CO (Model 8-10)	4	F-102A-70-CO (Model 8-10)	41*	TF-102A-35-CO (Model 8-12)	8*
F-102A-10-CO (Model 8-10)	3	F-102A-70-CO (Model 8-10)	11*	TF-102A-36-CO (Model 8-12)	6
F-102A-15-CO (Model 8-10)	5	F-102A-75-CO (Model 8-10)	42*	TF-102A-37-CO (Model 8-12)	3
F-102A-20-CO (Model 8-10)	9	F-102A-75-CO (Model 8-10)	98*	TF-102A-35-CO (Model 8-12)	7
F-102A-25-CO (Model 8-10)	7	F-102A-80-CO (Model 8-10)	89	TF-102A-40-CO (Model 8-12)	12
F-102A-30-CO (Model 8-10)	13	F-102A-90-CO (Model 8-10)	76	TF-102A-41-CO (Model 8-12)	18
F-102A-35-CO (Model 8-10)	17	F-102A-95-CO (Model 8-10)	54	TF-102A-45-CO (Model 8-12)	26
F-102A-40-CO (Model 8-10)	7	TF-102A-5-CO (Model 8-12)	4	TF-102A-CO (Model 8-12)	87
F-102A-41-CO (Model 8-10)	23	TF-102A-10-CO (Model 8-12)	5	F-102B (Model 8-24)	Became the F-106A
F-102A-45-CO (Model 8-10)	47	TF-102A-15-CO (Model 8-12)	5	F-102C	Canceled
F-102A-50-CO (Model 8-10)	38	TF-102A-20-CO (Model 8-12)	3	F3Y-1	U.S. Navy program
F-102A-51-CO (Model 8-10)	16	TF-102A-25-CO (Model 8-12)	2		considered and rejected
F-102A-55-CO (Model 8-10)	72	TF-102A-26-CO (Model 8-12)	3	Total	1,000

Conversions

QF-102 drones	2 (possibly more, but not many)
PQM-102 drones	200+

* Blocks 65, 70, and 75 among the F-102As and Block 35 among the TF-102As were broken into smaller sub-blocks with non-sequential serial numbers.

Chapter Eight

The XFY-1 Pogo

On 2 November 1954, the eyes of San Diegans turned skyward to see that "Pogo stick" airplane of which there had been a great deal of discussion in the newspapers. Right on cue, Skeets Coleman made his flight over the heart of the city, although he did not demonstrate a take-off or landing for the public. (Convair via Author's collection)

Since the beginning of aerial combat, both tacticians and aircraft designers lusted for a combat aircraft—other than a helicopter—that could take off from a runway no larger than its own shadow at noon. The first aircraft to demonstrate the viability of this impossible dream was a Convair delta.

The principal lineage of Convair delta-winged aircraft leads through a series of Air Force programs that began with the XF-92A and culminated in the B-58 and the F-106. In the meantime, however, Convair was involved in two delta-wing programs for the U.S. Navy that are important for the fact that they both pioneered radical new technology, and that they took that new technology further than it has been taken since.

The first of these programs involved the XFY-1 Pogo.

The idea of Vertical Take-Off and Landing (VTOL) for high-performance fighters has been a perplexing and obsessive one for aircraft designers for decades. Helicopters and autogiros could take off vertically, but they were—until the 1980s—perceived as being too fragile, too slow, and too vulnerable for the world of intense aerial combat.

During the spring of 1954, the Convair XFY-1 Pogo was placed in the U.S. Navy's vast blimp hangar at Moffett Field near San Jose, California, where it would make its first tethered vertical flights in undisturbed air. (Convair via Author's collection)

Convair engineers inside the Moffett Field blimp hangar mate the Allison XT40-A-6 turboprop engine to the XFY-1 Pogo in preparation for its first tethered flight on 4 June 1954. (Convair via Author's collection)

Convair test pilot James "Skeets" Coleman prepares to climb aboard the futuristic-looking XFY-1, which has been moved outside the hangar to the ramp at Moffett Field. (Convair via Author's collection)

With police directing traffic, the XFY-1 was trucked from San Diego to the Brown Field Auxiliary Naval Air Station in the fall of 1954. Although initial test flights occurred at Moffett Field in Northern California, the aircraft returned to Southern California for subsequent higher performance flight-test operations. (Author's collection)

To reach the XFY-1 cockpit, Skeets Coleman and his crew chief had to climb a 20-foot ladder. For making his historic first flights in a true VTOL aircraft, Coleman was awarded the Harmon Trophy. (Convair via Author's collection)

This changed with the British Aerospace Harrier. Created in the late 1960s, the Harrier proved itself in combat with British forces during the Falklands War in 1982, and it was the basis for the McDonnell Douglas AV-8B Harrier that proved itself in combat with the U.S. Marine Corps in the Gulf Wars. Though the similar Soviet Yakovlev Yak-36 Forger became operational in the late 1970s, the Harrier was the only VTOL combat aircraft to actually see combat during the twentieth century. The Harrier was a milestone aircraft and, aside from the Forger, it was an isolated milestone. Until the advent of the Short Takeoff and Vertical Landing (STOVL) Lockheed Martin F-35, there was nothing else with its capabilities.

The first serious attempts at developing a VTOL fighter were probably those undertaken in Germany during World War II at a time when Allied bombers were destroying German airfields. If only, thought the Luftwaffe planners, there was a high-performance interceptor that didn't *need* a runway.

The Bachem Ba 349 Natter (Viper) may be considered a precursor to true VTOL aircraft, but it was really designed for vertical takeoff alone. It was actually just a missile with a human guidance system. Landing was not considered to be a necessary part of the scenario. While the Natter was being developed, work was proceeding on the idea of a recoverable and reusable VTOL fighter. These efforts originated with Heinz von Halem at Focke-Wulf Flugzeugbau AG in September 1944.

The aircraft that von Halem proposed was called the "Triebflüegel," a term implying that the motive power was also the wing. It was an aircraft without a conventional wing that had a huge three-bladed propeller around its waist. This propeller, whose diameter was greater than the length of the fuselage itself, was powered by a vectorable ramjet engine at the tip of each blade. The Focke-Wulf Triebflügel would need no runway. It could take off from any patch of level ground. Had there been enough time left in the war for the

Skeets Coleman prepares to climb into the cockpit and fly the Pogo while lying on his back with his feet placed above him on the rudder pedals. This awkward position presaged that of astronauts aboard the space capsules of the 1960s. (Convair via Author's collection)

The XFY-1 Pogo "hops" into the air. Beginning in August 1954, the aircraft took off vertically many times, something never accomplished by its Lockheed rival. One can only imagine the incredible noise that must have been generated by this turboprop aircraft. (Convair via Author's collection)

Triebflügel to actually go into production, it might have been the ideal air-defense fighter, because the Luftwaffe could have based it almost anywhere.

After World War II, the U.S. Navy became interested in the same idea. It would be to their advantage to have a fighter aircraft to provide air defense for operations that might take place when and where an aircraft carrier would not be available. The Navy wanted a combat aircraft that operated from the deck of virtually any type of ship—just as helicopters would be able to operate from helipads on vessels from cruisers to transports.

Studies were initiated by the Navy Bureau of Aeronautics late in 1947, and VTOL proposals from a half-dozen manufacturers were submitted. In March 1951, less than a year after the start of the Korean War, the Navy ordered prototype VTOL fighters from both Lockheed and Convair. Each would build a pair of prototypes under the respective designations XFV-1 and XFY-1. The designations stood for "experimental fighter," with "V" being Lockheed's manufacturer code (inherited from its Vega component) and "Y" was the letter assigned by the Navy to Convair back when it was still Consolidated Vultee.

The Lockheed XFV-1 posed on its tail. This is how it was intended to take off, but a successful vertical take-off was never achieved. (Author's collection)

The Convair aircraft was named "Pogo" because its vertical take-off reminded some of a pogo stick. The Lockheed aircraft was initially unnamed, but it was later nicknamed "Salmon" after legendary Lockheed test pilot Herman "Fish" Salmon.

Both aircraft would be designed around the huge, 5,100-shaft-hp Allison XT40-A-6 double-turboprop engine driving two massive contra-rotating, three-bladed Curtiss propellers that were 16 feet in diameter. This powerplant—and not the aerodynamics of the wings—was to theoretically lift the 8-ton machines straight up!

It was planned that the test aircraft would later be retrofitted with the Allison XT40-A-14, delivering 7,100 shaft-hp, and that production series aircraft would use the even more powerful Allison T54. However, in the time frame of the development of these aircraft, even the Allison XT40-A-6 was still experimental and not flight rated until 1954.

At Convair's Lindbergh Field facility in San Diego, Dick Sebold, the company's director of engineering, would head the XFY-1 program. At Lockheed's Burbank, California, plant, Art Flock would head the VTOL fighter project. It had crossed the desk of Chief Engineer Clarence "Kelly" Johnson, whose Advanced Development Projects Skunk Works team had built the P-80, America's first operational jet fighter. However, Johnson was not enamored with the concept, and the Skunk Works had its plate full of projects that would lead to such milestone aircraft as the F-104 Starfighter, the U-2, and the SR-71 Blackbird.

Aside from sitting on their tails pointing straight up, the XFV-1 and XFY-1 were very different machines. The Lockheed aircraft had straight wings and four swept tailplanes. The Convair aircraft was delta-winged, with two vertical stabilizers on opposite sides of the stubby fuselage. At the wingtips were pods that were designed to accommodate 48 2.75-inch Mighty Mouse Folding Fin Aerial Rockets in production aircraft.

Lockheed decided to do its initial testing with the aircraft taking off and landing horizontally, and thus supported by the aerodynamic lift of its wings. In order to do this, the company fitted its first XFV-1 (Bureau of Aeronautics tail number 138657) with "temporary" fixed landing gear. Convair, on the other hand, planned for the first Pogo take-offs and landings to be vertical.

Lockheed test tilot Herman "Fish" Salmon made the first taxi tests in the XFV-1 at Edwards AFB during December 1953, and actually lifted off slightly on 23 December. His official first flight with a conventional horizontal take-off and landing took place on 16 June 1954, after the XT40-A-6 had been cleared for flight operations.

Twelve days earlier, however, Convair's James "Skeets" Coleman made the debut flight in the first XFY-1 Pogo (Bureau of Aeronautics tail number 138649), taking off and landing vertically. The early Convair flight tests were conducted inside the enormous blimp hangar at Moffett Field in San Jose, California, which has a 195-foot ceiling and which ensured completely undisturbed air in which to fly the new aircraft. During these initial flights, the aircraft was tethered to prevent it from tipping away from vertical.

On 1 August, Coleman made the first untethered series of vertical take-offs and landings on the tarmac outside the hangar.

With his cockpit canopy in the open position, Skeets Coleman thunders over Brown Field Auxiliary Naval Air Station after having taken off vertically and converted to horizontal flight in the XFV-1. (Convair via Author's collection)

"It's more maneuverable and responds faster than any plane I've ever flown," Coleman observed of the Pogo. "We'll do a little more maneuvering, try a few tricks, as we go along."

And so he did. Two months later, Coleman made the first transition to horizontal flight after a vertical take-off in the XFY-1. Later, Convair flight testing moved to the Brown Field Auxiliary Naval Air Station, where Coleman made the transition to horizontal flight many times. On 2 November 1954, he made a widely publicized flight over downtown San Diego. For making his historic first flights in a VTOL aircraft that transitioned to horizontal flight, Coleman was awarded the Harmon Trophy, which honors Americans who have made significant contributions to aviation.

In the course of 32 test flights, Salmon never made a vertical take-off or landing in the Lockheed airplane, although he did make the transition from horizontal to vertical flight after a horizontal take-off.

Both Convair and Lockheed would soon discover, however, that it wasn't the take-offs that were the inherent design flaw in the concept. It was the landings.

Because the pilot literally had to look over his shoulder to back one of these aircraft down, landings were found to be impractical and even dangerous! Landing the airplanes on a sunny day at a test field was one thing, but imagine trying to land one on the pitching deck of a ship during bad weather or under enemy attack.

Kelly Johnson never liked the concept. He said, "We [Lockheed] practiced landing on clouds, and we practiced looking over our shoulders. We couldn't tell how fast we were coming down, or when we would hit. We wrote the Navy: 'We think it is inadvisable to *land* the airplane.' They came back with one paragraph that said, 'We agree.'"

Both XFV-1 and XFY-1 programs were canceled in 1955 at the request of the contractors, and the second prototype of each aircraft was never made ready for flight. Neither firm wanted to be involved in the continuation of a project that was so clearly misguided. No FY-2 or FV-2 production aircraft would ever be built. The Convair test aircraft had logged 40 hours of flight test; the Lockheed XFV-1 completed about 23 hours. Both of these aircraft still survive: The Lockheed XFV-1 is in the collection of the Smithsonian National Air and Space Museum and the Convair XFY-1 is at the San Diego Air & Space Museum.

The true legacy of this early 1950s VTOL program is told not in aircraft that were derived from these aircraft—because there were no successor aircraft—but in a way of thinking about aircraft design, outside the box. In my 1994 interview with Roland J. "Shorty" Hogue, Sr., who was supervisor of the machine shop during the XFY-1 Pogo program, he said, "I think the Pogo was great. It was the first ship that made everybody think ahead, and see what we could do. What we have today comes from all those airplanes. They were handmade."

CONVAIR XFY-1 (MODEL 5) PRODUCTION CLOSE-UP

XFY-1	2
FY-2	(Production series considered, but not ordered)

The Lockheed XFV-1 in horizontal flight with the apparatus that was used for horizontal take-offs. The Lockheed aircraft was able to convert to vertical flight after a horizontal takeoff, but it never took off vertically. (Author's collection)

Unlike the Lockheed XFV-1, the Convair XFY-1 was not configured for horizontal take-off, so in order to transport it horizontally on the ground it was mounted to this specially designed hydraulic apparatus and slowly lowered from vertical. This trailer was used to transport the Pogo between San Diego and Brown Field Auxiliary Naval Air Station. (Convair via Author's collection)

This, unfortunately, was the hard part. Skeets Coleman's head can be seen pivoting as he lies on his back looking upward, attempting to descend to the tarmac. (Convair via Author's collection)

The XFY-1 was certainly a unique sight during its test flights over Southern California. (Convair via Author's collection)

CONVAIR XFY-1 (MODEL 5) SPECIFICATIONS

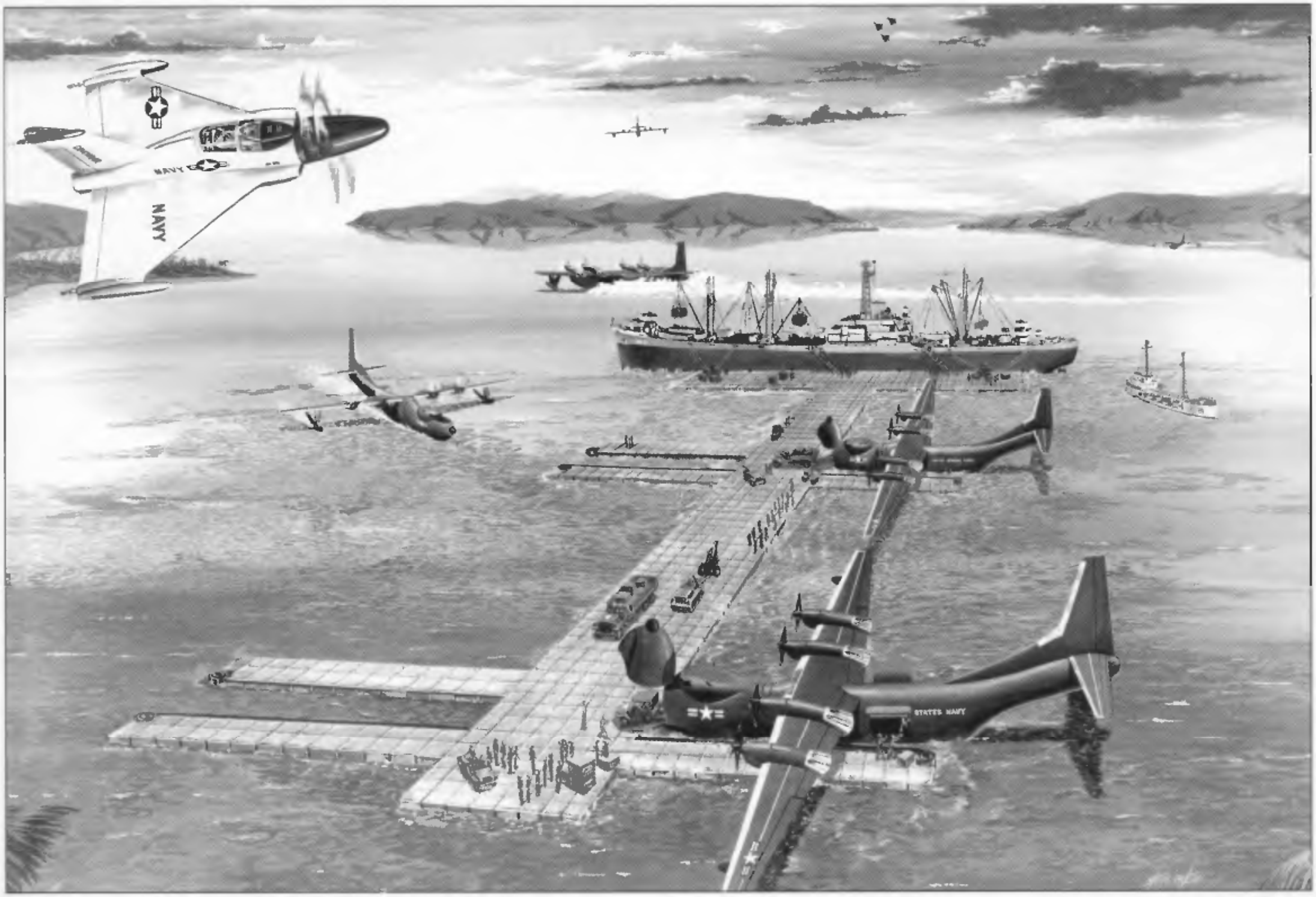
Dimensions
Wingspan: 27 feet 8 inches (8.4 meters)
Length: 32 feet 3 inches (9.8 meters)
Tail span: 21 feet 8 inches (6.5 meters)
Wing area: 355 square feet (33 square meters)

Weights
Empty: 11,139 pounds (5,060 kilograms)
Gross: 14,250 pounds (6,470 kilograms)
Combat: 13,250 pounds (6,016 kilograms)

Powerplant
1 Allison XT40-A-6 double turboprop engine rated at 5,100 shaft-horsepower

Performance
Top speed: 474 mph (763 kph) at sea level
Service ceiling: 37,500 feet (11,440 meters)
Estimated range: 500 miles (805 kilometers)
Rate of climb: 9,980 feet (3,045 meters) per minute

Armament
None, but production aircraft would have had a 20mm cannon, and 48 2.75-inch Folding Fin Aerial Rockets in wingtip pods.



In this fanciful illustration, a Convair FY-2 flies top cover for a U.S. Navy operation involving a floating island serviced by transport ship and a fleet of Convair R3Y Tradewind flying boats. The Tradewinds became a reality—albeit in small numbers—but the dream of FY-2s routinely operating from miniscule landing zones the size of their shadows never materialized. (Convair via Author's collection)

CHAPTER NINE

THE F2Y-1 SEADART

YF2Y-1 SeaDart taxis through San Diego Bay, its ski still submerged beneath the surface. This picture of a delta-winged jet traveling through the water is a reminder of how truly futuristic both the airplane and the overall jet seaplane concept were for 1954—or even today, for that matter. (Convair via Author's collection)

To paraphrase Shorty Hogue, there were many examples of Convair engineers thinking ahead during the early 1950s. Thinking ahead led to the exciting, if flawed, Pogo, but it also led Convair to conceive of and build the world's first supersonic seaplane. Before and during World War II, Consolidated had made a name for itself with seaplanes such as the PBY Catalina. After the war, the company's signature warplanes would have delta wings. In one aircraft, the two lines crossed. It was here that Ernest Stout's team at Convair's hydrodynamic research laboratory pushed the limits of innovation by proposing to put an F-102 on *water skis!*

The idea of a seaplane jet fighter was not new. The experimental, straight-winged Saunders-Roe SR.A/1 had first flown in 1947, and had been evaluated by Britain's Royal Air Force through 1951. The idea of a seaplane jet fighter that could compete with conventional high-performance jet fighters was an untested concept when Stout's team began to look into it.

After World War II, Convair remained thoroughly committed to a new generation of large seaplanes at a time when most companies (Martin was another big exception) were concentrating on landplanes. In the early postwar years, Convair built its last family of large flying

In the fall of 1952, work was completed on the Convair Model 2 (or more technically, Y2-2, for service test Model 2, second iteration). Ordered by the U.S. Navy under the designation XF2Y-1, this delta-winged seaplane fighter was the culmination of work that had been ongoing at the Convair hydrodynamic research laboratory under its Project Skate. (Convair via Author's collection)

boats for the U.S. Navy. These included the Model 117 that was ordered as the P5Y patrol plane, and the Model 3, a transport derivative of the P5Y that served the Navy as the R3Y Tradewind.

Meanwhile, Stout and the hydrodynamic research laboratory undertook *Project Skate,* a series of extensive studies of a wide variety of seaplanes and seaplane-basing scenarios that were evaluated by the Navy. Among these concepts was that of a jet seaplane that emerged from Convair drawing boards before the SR.A/1 first flew. Gradually *Project Skate* led to *Project Betta,* the early studies that narrowed the project to a high-performance, delta-winged seaplane. The Navy also studied similar proposals from other companies, including Boeing and Lockheed, but finally settled on the Convair proposal in January 1951. The design for the Convair craft that evolved from *Betta* was based on an amalgam of a blended-hull fuselage design and a wing design similar to that envisioned for the F-102.

Two prototype aircraft, Convair Model 2 (Y2-2), were ordered under the Navy designation XF2Y-1. Eventually, the aircraft would be named "SeaDart." Like the F-102 that Convair was designing for the U.S. Air Force, the XF2Y-1 would have a delta wing but, unlike the F-102, two engines would power it. The U.S. Navy mandated two engines for added safety in overwater operations. If one flamed out, the pilot could still limp back to land on the power of the other engine. The engine choice was the new Westinghouse XJ46-WE-2, which delivered 6,100 pounds of thrust, but it was not yet available, so Convair substituted the existing 3,400-pound-thrust Westinghouse J34-WE-32.

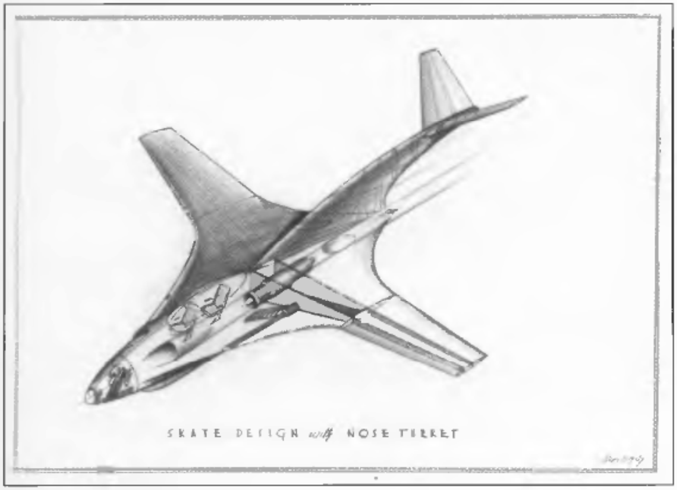
For landings and take-offs, the SeaDart literally used a water ski. Instead of conventional landing gear, the hydrodynamic research laboratory designed the aircraft with two retractable skis beneath the forward fuselage. There were small wheels on the skis so the SeaDart could taxi from land, down a ramp, and into the water to take off. Landings were to be on the water.

The Navy was extremely impressed with Convair's proposed aircraft and backed it with orders. On 28 August 1952, even before the first flight of the XF2Y-1 prototype, they ordered a dozen F2Y-1 production aircraft. This was later increased to 14, plus four YF2Y-1 service test aircraft. Whereas the U.S. Air Force did not order guns to be included as armament for its production F-102s, the Navy specifically ordered four 20mm cannons to arm its production SeaDarts.

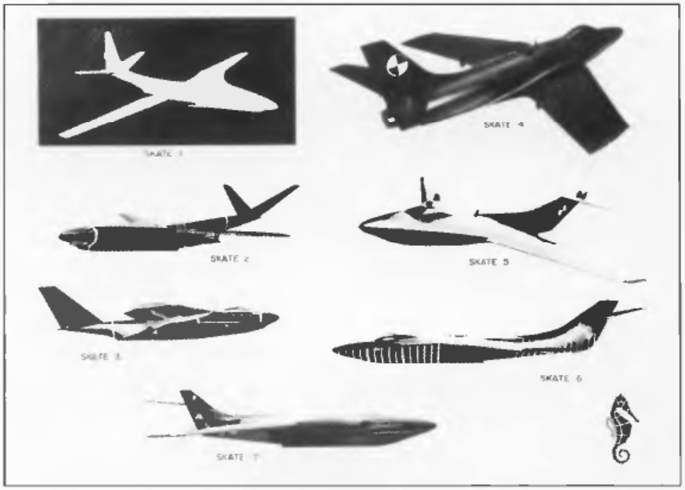
The first Convair Model 2 (Y2-2), ordered by the Navy under the designation XF2Y-1, was equipped with twin hydro-skis. (Convair via Author's collection)

Taxi tests of the first XF2Y-1 (Bureau of Aeronautics tail number 135762) began on 14 December 1952, and it became airborne for the first time on 14 January 1953. As he had with the XF-92A in 1948, Convair test pilot Ellis "Sam" Shannon allowed the aircraft to "hop" into the air briefly before it was scheduled to actually fly. The taxi tests demonstrated that the aircraft was adversely affected by hitting certain wave patterns, so the first flight was not made until 9 April. It probably pleased the Navy that its delta-winged fighter made its first flight six months before the Air Force's F-102.

Timing may have been cause for celebration at the Navy's Bureau of Aeronautics, but the aircraft's performance was not. The first SeaDart suffered from vibration and instability after take-off because



This early concept for a V-tail armed jet seaplane emerged from Convair's hydrodynamic research laboratory in February 1947 as part of Project Skate. (Author's collection)



The broad range of designs that Convair's hydrodynamic research laboratory considered for the Project Skate seaplane fighter. (Author's collection)

Convair's hydrodynamic research laboratory built and tested this subscale model of a Project Skate swept-wing jet fighter. (Author's collection)

Project Skate proposed that a seaplane jet fighter could operate in cooperation with a Navy attack submarine. The aircraft itself was not submersible, but it could land to refuel and rearm from the sub. (Author's collection)

Among other projects, Convair did actually consider developing a submersible aircraft. Three turbojet engines were augmented by an engine to turn the aft prop while under water. (Author's collection)

This wind-tunnel model of the Convair Betta illustrates how it served as the technical bridge between the Project Skate designs and the XF2Y-1 SeaDart. The delta wing is there, but the design is still evolving. (Author's collection)

of the cumbersome twin-ski landing gear. The second XF2Y-1 was canceled in October 1953 in favor of building a YF2Y-1 with a single ski. By this time, the Area Rule had been discovered during F-102 wind-tunnel testing, and there was discussion that F2Y-2 production SeaDarts should incorporate that feature in their design. However, by now the Navy was having a hard time keeping alive a problematical program that embodied such radical new technology. In March 1954, the SeaDart order was cut back to just five aircraft, none of them to be Area Ruled.

Soon the YF2Y-1 (BuNo. 135763) was completed, and flight testing began. With the J46-WE-2 engine now installed, there was hope for improved performance. On 3 August 1954, Convair test pilot Charles "Chuck" Richbourg took the aircraft supersonic in a shallow dive, marking the first time that a seaplane ever exceeded Mach 1. With the Area Ruled fuselage, F2Y-2s could have done so routinely but without it, the dive was necessary.

The only man to break the sound barrier in a seaplane during the twentieth century, Richbourg was born in St. Augustine, Florida, and had served as a naval aviator during World War II. He had studied at the Massachusetts Institute of Technology before joining Convair as a test pilot. He was also on one of the first lists of potential astronaut candidates.

The first SeaDart test flights had been made on the calm waters of San Diego Bay, but Richbourg conducted take-offs and landings in the open ocean, and demonstrated that an operational SeaDart could be retrieved by naval vessels at sea after it landed. He also demonstrated that Convair had started to get a handle on the problem of taxiing through choppy water, although this issue remained without a fully satisfactory solution.

On 4 November 1954, two days after Skeets Coleman made his heavily publicized flight over downtown San Diego in the XFY-1 Pogo, it was Richbourg's turn in the YF2Y-1 SeaDart. He took off in front of a host of U.S. Navy officials, invited dignitaries, and the media. As Richbourg made a low-level high-speed pass, the airframe suddenly disintegrated. As it was reported in the following week's issue of *Time* magazine, "300 feet above the water, the SeaDart fell apart in a gush of flame and a shower of metal fragments. Pilot Richbourg lived only two minutes after rescuers pulled him from the bay." The cause was vibration due to pitch oscillation.

To continue the test program after the YF2Y-1 crash, the XF2Y-1 was retrofitted with revised single-ski landing gear and flown in that configuration between December 1954 and January 1956. The second YF2Y-1 was first flown in March 1955 with a revised twin-ski configuration, as Convair continued to work on the nagging problems that the SeaDart encountered when taxiing, which proved physically punishing to the aircraft's test pilots. After trying the twin-ski approach in operations in the open ocean, Convair and the Navy retired the second YF2Y-1 on 28 April 1955. Two additional YF2Y-1s were built, but they were never flown.

A year-and-a-half later, the XF2Y-1 was retrofitted with a small hydrofoil ski, and taxi tests resumed in March 1957. When these proved the hydrofoil to be unacceptable, the SeaDart program finally sputtered

to a stop. Five years later, when Air Force and Navy aircraft nomenclature systems were merged, the numbering restarted with 1, and existing operational aircraft were redesignated. Even though the SeaDart program was apparently over well before 1962, the YF2Y-1 was officially redesignated as YF-7A. Perhaps the Department of Defense had future plans for the SeaDart that were never disclosed. In any case, these future plans, if they ever existed, apparently have yet to materialize.

As with the XFY-1 Pogo, the four surviving SeaDarts—including the two that were never used—escaped the wrecking ball and survive today. One is in the collection of the Smithsonian National Air and Space Museum, another is at NAS Willow Grove in Pennsylvania, and another is languishing at the airport in Lakeland, Florida. The fourth is at the San Diego Air & Space Museum, a short distance from where the program was born and where it lived and died.

CONVAIR XF2Y-1 SEADART (MODEL 2) SPECIFICATIONS

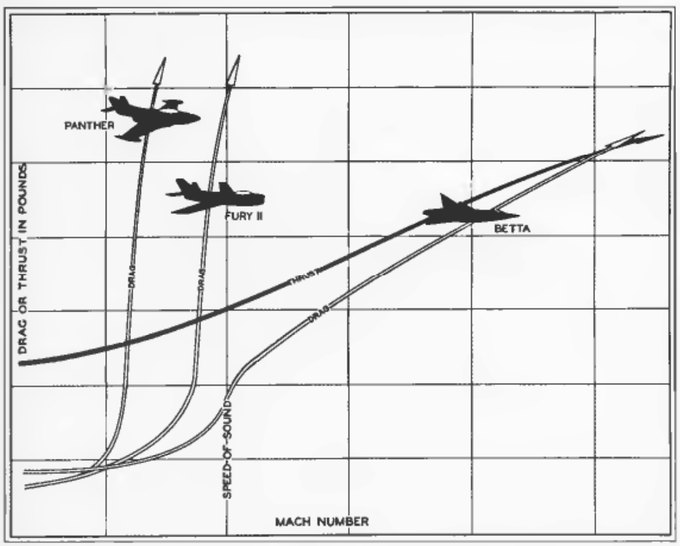
Dimensions
Wingspan: 33 feet 8 inches (10.3 meters)
Length: 52 feet 7 inches (16 meters)
Tail height: 20 feet 9 inches (6.3 meters)
Wing area: 563 square feet (52.4 square meters)

Gross weight
21,500 pounds (9,765 kilograms)

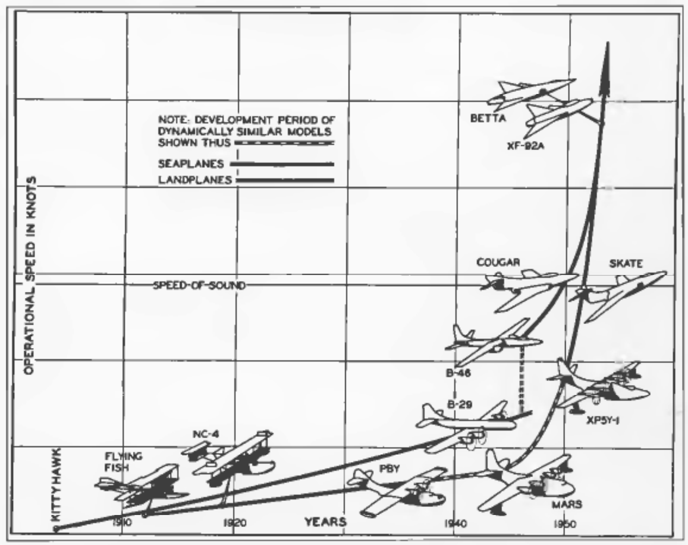
Powerplant
2 Westinghouse J46-WE-12B turbojet engines rated at 5,725 pounds (2,600 kilograms) of thrust

Performance
Top speed: 724 mph (1,166 kph) at sea level
Service ceiling: 42,500 feet (13,000 meters)
Rate of climb: 17,100 feet (5,215 meters) per minute

Armament
None, but production aircraft would have had four 20mm cannons, and provisions for 2.75-inch Folding Fin Aerial Rockets in wingtip pods.



Before the aerodynamic advantages of Area Ruling were discovered by noted aerodynamicist Richard Whitcomb, Convair imagined that its Betta seaplane fighter would have a vastly lower thrust-to-drag ratio than the two leading Navy jet fighters of that era, namely the Grumman F9F-5 Panther (precursor to the F9F-8 Cougar) and the North American FJ-1, swept wing variant of the original FJ Fury. (Convair via Author's collection)



This graphic generated by Convair in about 1951 was for the eyes of Navy planners thinking about the evolution of aircraft performance. It placed the notional Project Betta jet fighter in the context of early flying boats and high-performance jet fighters—notably Convair's own XF-92A and the Grumman F9F Cougar, then one of the Navy's top fighter aircraft. Interestingly, Convair's hypothetical Skate fighter was on par with the Cougar. (Convair via Author's collection)

First flown in 1954, the YF2Y-1 was fitted with a single hydro-ski instead of the pair of skis with which the XF2Y-1 was equipped. Convair later went back to the twin-ski configuration for the YF2Y-1. (Convair via Author's collection)

This view of a YF2Y-1 over San Diego is a haunting reminder of 4 November 1954, the fateful day of Chuck Richbourg's deadly flight over the city, when vibration due to pitch oscillation caused the aircraft to shake apart and disintegrate before falling into the bay. (Convair via Author's collection)

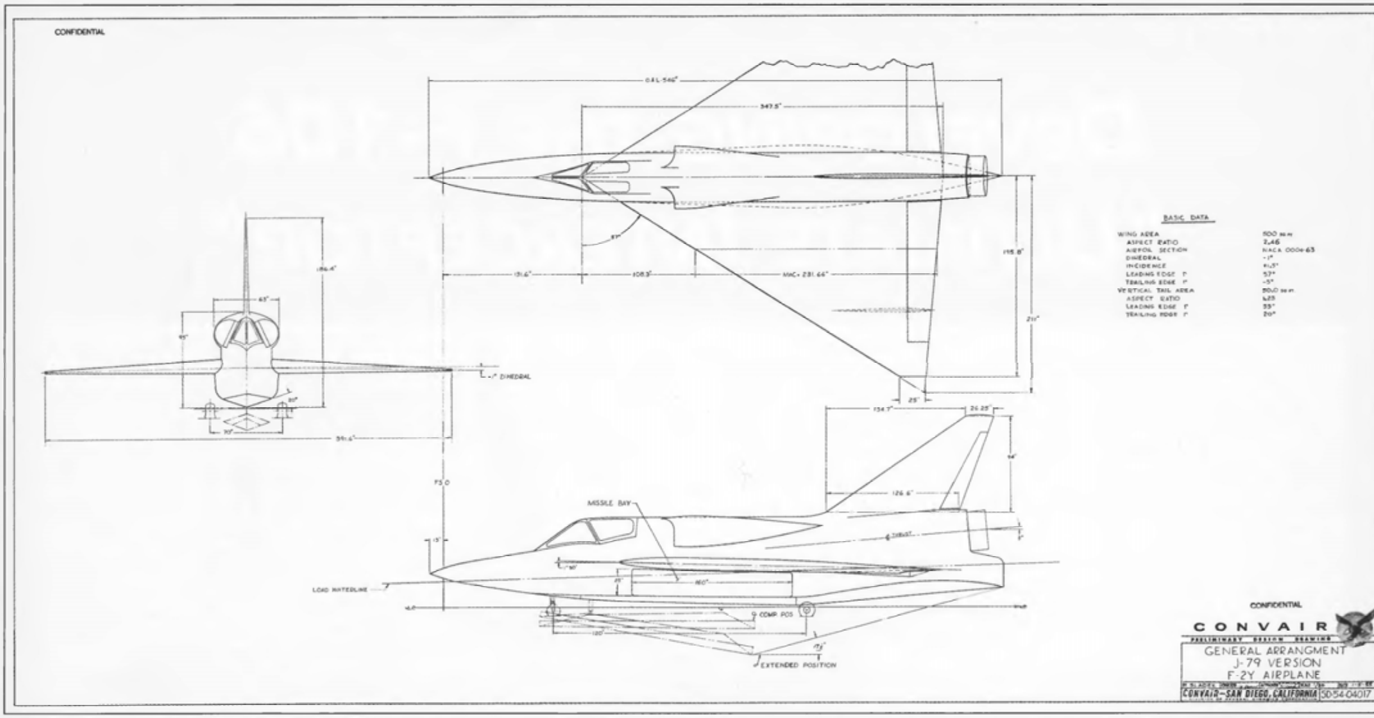
A trio of operational F2Y-2 SeaDarts roars over the beachhead as Marines go ashore from both conventional landing ships and Convair R3Y Tradewinds. This scenario was part of the U.S. Navy's early 1950s tactical concept for augmenting its surface fleet with aircraft that function as landing craft, and for jet fighters that needed neither an aircraft carrier nor an airfield. One F2Y-2 has landed in the water and has been pulled onto the beach. (Author's collection)

CONVAIR XF2Y-1 SEADART (MODEL 2) PRODUCTION CLOSE-UP

XF2Y-1	1 (2 ordered, 1 canceled)
YF2Y-1 (YF-7A)	4
F2Y-1	(14 canceled)

Close-up view of a single-ski YF2Y-1 SeaDart on the Convair ramp. This configuration failed to conquer the buffeting difficulties experienced by the aircraft during its initial taxi tests, which proved quite physically punishing to its pilots. (Convair via Author's collection)

After using the single-ski arrangement in the first YF2Y-1, Convair completed the second YF2Y-1 with a revised twin-ski configuration, which was first flown in March 1955. (Convair via Author's collection)



This January 1955 drawing illustrated a future F2Y concept that borrowed elements from the F-106A as the original SeaDart shared design features with the F-102A. This variant was to have been powered with the Mach 2 General Electric J79 turbojet engine that was earmarked for the B-58 Hustler. Would the aviation world have been ready for a Mach 2 seaplane? (Convair via Robert Bradley)

The hulk of XF2Y-1, Bureau of Aeronautics No. 137634, in 1979. Its outward appearance has since been restored, and it is now proudly on display at NAS Willow Grove in Pennsylvania. (Terry Panopalis)

DEVELOPING THE F-106 "ULTIMATE INTERCEPTOR"

A high-angle, front three-quarter view of the third F-106A (then called YF-106A). Convair test pilot Richard Johnson made the historic first flight on 26 December 1956. (Convair via Author's collection)

By the mid 1950s, Convair had literally defined the world of delta-winged aircraft, and it was Convair that was to create an airplane to fulfill a concept that the Air Force's Air Defense Command ambitiously referred to as the "Ultimate Interceptor."

As early as 1951, it had become apparent that the F-102 would not be in service in time to fulfill the U.S. Air Force requirement for its Weapon System 201A 1954 Interceptor. To be charitable, both to Convair and to eagerly ambitious Air Force planners, the F-102 project had pushed the technological limits hard and fast. The Air Defense Command had aimed higher than they should have, but they had achieved more than they would have if not for aiming high.

As we have seen, on 24 November 1951, the Air Force made the decision to acquire the Convair Model 8 interceptors on a *two-track* development plan. One track would lead quickly to getting the F-102A (Model 8-10) into service as soon as practical. On the other track, the Air Force aimed still higher and began planning for Weapon System 201B, or what the service would now call the Ultimate Interceptor. Initially, this delta-winged aircraft, Convair Model 8-24, carried the designation F-102B, but as the sheets on the drawing board rapidly began to change, the project was later redesignated as F-106A.

Among the lessons about aircraft technology that had been learned during World War II—and through the 1950s—was that aircraft became obsolete quickly. Though it is hard to imagine today, when combat aircraft have useful lives exceeding two decades, in the 1950s it was believed that aviation technology was moving so fast that aircraft would be obsolete within five years. Even if procurement funds were tight, an aircraft's successor had to already be on the drawing board when it made its first flight.

With the engine and electronics thus delayed for WS-201A, the Air Force decided they would now be incorporated into a system designated WS-201B. In other words, of all the major WS-201A components, only Convair's airframe was on schedule. The Air Force hoped that the other components would be ready in time for WS-201B, the Ultimate Interceptor.

The idea initially was that both WS-201A (F-102A) and WS-201B (F-102B/F-106A) would share the same basic airframe. The WS-201B, however, would use the Wright Aeronautical J67 turbojet engine that had originally been specified for the earlier interceptor, but which was delayed. The Hughes MX-1179 electronics package, including the MA-1 Automatic Weapon Control System (AWCS), which was also supposed to have been part of WS-201A, was also delayed. It too, was earmarked for the WS-201B. When it finally was ready, the MA-1 marked the milestone of being the first digital computer ever installed in an airplane.

However, the WS-201B airframe was financed with "production" funding, while the engine and electronics were paid for with "research" funding, which was harder to come by, even against the backdrop of Cold War tensions.

The first Convair YF-106A Delta Dart was virtually handmade, as are most prototypes. There was still a way to go before it could truly be called the Ultimate Interceptor, but it was on the right track. (Convair via Author's collection)

In early 1955, Wright Aeronautical was still having so much trouble developing the J67, a variation on the Bristol Olympus, that the Air Force changed horses in midstream. The Pratt & Whitney J75, a more advanced version of the J57, was specified for use in WS-201B.

By the end of 1955, the Hot Rod configuration of the YF-102 with its Area Ruled fuselage was a demonstrable success, and the WS-201B mock-up was nearing completion. Around this time, the Air Force accepted a Convair proposal with regard to the cockpit that would prove problematic later on. As part of its electronics package, Hughes was developing its Horizontal Situation Indicator (HSI). In order to guarantee the pilot an unrestricted view of this display, the control stick, usually in the center of the cockpit, was moved to the side.

In November 1955, the Air Force felt confident in placing its initial orders for WS-201B. At the same time orders were placed for 562 F-102As, the Air Force made a commitment for 17 Convair Model 8-24 aircraft to be built in San Diego under the designation F-102B, but the definitive contract was not issued until 18 April 1956. This contract was essentially a research-and-development contract. It called for the first two prototypes to be delivered in December 1956 and January 1957, with the remaining 15 test aircraft starting to come off the line in July 1957.

The auxiliary power units are still attached, but the first F-106A prototype is otherwise ready to go. The aircraft's official debut occurred in the waning days of 1956 to meet stringent Air Force contractual requirements. (Convair via Author's collection)

Two months after the contract, on 17 June 1956, the F-102B was officially redesignated as the F-106A. The official name, Delta Dart, would be assigned a year later. As for how it envisioned the program, the Air Force announced on 18 August that the philosophy that originated with Cook-Craigie was still alive and well. The new aircraft would be ordered into production, even as the aircraft was being tested.

On 28 September, the Air Force told Convair what it was looking for in the operational F-106A that it expected to be available in August 1958. This Ultimate Interceptor should be "capable of intercepting and destroying hostile vehicles under all weather conditions, at all altitudes up to 70,000 feet, and within a radius of 375 nautical miles. Interceptions would be accomplished at speeds up to Mach 2 at 35,000 feet."

Amended general operational requirements issued on 19 June 1957 would reduce the required combat ceiling from 70,000 feet to 55,000 feet. The combat radius requirement was later increased to 633 nautical miles. The general operational requirements for the F-102A at this time were Mach 1.2 with a combat ceiling of 54,000 feet.

The Air Force also stipulated that flight would be "under automatic guidance provided by the ground environment and the aircraft's [MA-1] fire-control system." Meanwhile, to guarantee the aircraft's success at intercepting enemy aircraft at any altitude, the F-106A would be equipped with an Airborne Moving Target Indicator (AMTI) system, Broadcast Fighter Control (BRFICON), and Tactical Air Navigation (TACAN).

The armament specified in the 19 June 1957 document included the unguided Douglas MB-1 Genie nuclear-capable rocket, as well as a selection of four GAR-3, GAR-3A, and/or GAR-4A (later AIM-4E, AIM-4F, and AIM-4G) Super Falcon guided missiles that were designed specifically for use by the F-106. The AIM-4E and AIM-4F were radar-guided, while the AIM-4G used infrared-homing guidance. Meanwhile, Hughes was also developing the GAR-11 (later AIM-26A) nuclear-capable missile. This would be used by the F-102A, while the F-106 would use the more potent Genie as its nuclear punch. With a range of about six miles, the Genie could carry a 1.7-kiloton W25 warhead with a blast radius of about 1,000 feet.

As had been the case with the F-102A, the missiles were to be carried within an internal weapons bay in order to reduce aerodynamic drag, which would have slowed the F-106A if the missiles were hung on external weapons pylons. The launch system was designed so that the missiles, other than the AIR-2A Genie, would be launched as a two-missile salvo, but not singly. The pneumatic release system contained sufficient compressed air to open the bay doors, and then to release two pairs of Super Falcons. In an anticipated typical intercept scenario, the infrared-guided missiles would be launched first, with the AIM-4Es being considered as the backup pair.

Operationally, it was intended that the F-106A would conduct both localized "point intercepts" and more general "area intercepts"

under the control of Semi-Automatic (sometimes called Semi-Automated) Ground Environment (SAGE) centers. This system was theoretically capable of interfacing with the F-106's MA-1 fire-control system to control both the aircraft and its weapons, but in practice, it was used only to relay data.

SAGE was developed at the Massachusetts Institute of Technology's Lincoln Laboratories at the same time that Lincoln was developing the technology for the DEW Line and other such defensive systems. Work began on the first SAGE complex at McChord AFB in 1957, and within a few years there was a network of 22 computerized command and control centers throughout the United States. SAGE's integrated radar and computer technology also later contributed immensely to the development of civilian air traffic control systems, although SAGE itself would become less important as the threat of Soviet ICBMs superseded the threat of Soviet bombers during the 1960s. In 1979, SAGE would be replaced by Regional Operations Control Centers.

Just as the F-102A interceptor was complemented by the TF-102A training aircraft, so too would the F-106A have a two-seat trainer variant. Developed by Convair as its Model 8-27, this aircraft would be ordered by the Air Force under the designation F-106B. Originally, it was to be designated as TF-106A, but when it was decided to make the trainer combat capable, it was designated as F-106B. This was well before the first aircraft was built.

Equipped with identical controls, the two seats in the F-106B would be in tandem, rather than side-by-side as in the TF-102A. The forward fuselage was redesigned to accommodate the second seat, but there would be no lengthening of the fuselage. Though the aircraft would be built in San Diego (as were the F-106As), the cockpit development was done by Convair at its Fort Worth plant. The F-106B would be designed with the Hughes AN-ASQ-25 fire-control system, an equivalent to the MA-1 specified for the F-106A.

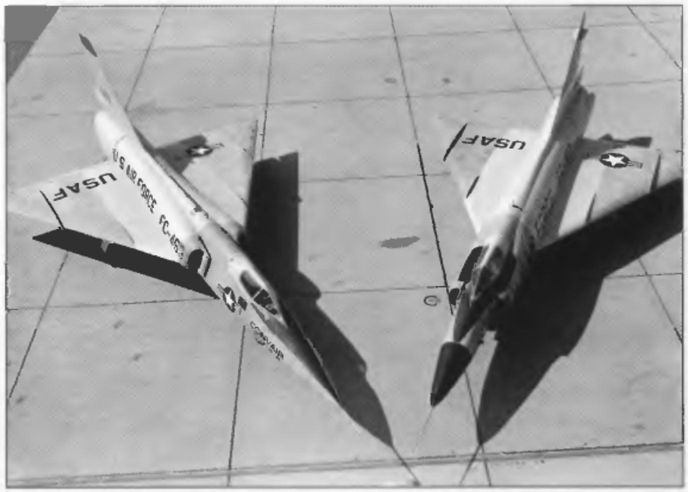
The formal decision to go ahead with the F-106B came on 3 August 1956. The mock-up was completed in less than six weeks and it was first inspected by the Air Force at Convair's Fort Worth plant on 13 September, the day after they viewed that of the F-106A. Initial acquisition of the F-106B came as an add-on to the third F-106A contract, with the formal F-106B contract issued in June 1957.

The first F-106A (tail number 56-451) was trucked from the Convair factory in San Diego to Edwards AFB. This first aircraft is sometimes referred to as the "YF-106A," but according to the aircraft record card, it was always just designated as F-106A. The 20-minute initial flight came on 26 December 1956, with Convair test pilot Richard Johnson at the controls. The date was apparently chosen in order to get the aircraft off the ground before the end of the calendar year to meet stringent Air Force contract requirements that dated back to the early days of the 1954 Interceptor program.

The second F-106A aircraft made its debut two months later on 26 February 1957. The first flight with a U.S. Air Force pilot at the controls came on 29 April 1957, with the aircraft reaching a speed of Mach 1.9 and an altitude of 57,000 feet. In its eagerness to keep the program moving along, the Air Force that month approved "conditional acceptance" of aircraft that had been earmarked for flight test. The initial aircraft were powered by the service test version of the new J75 engine, designated as YJ75-P-1, as Pratt & Whitney worked to get the production variant, the J75-P-9, into production.

The subsequent deliveries involved the F-106s being flown from San Diego to Convair's facility at Palmdale, a short distance from Edwards AFB, where they were fitted out for their official delivery to the Air Force. The program moved into its Category II flight-test phase in May 1957. During this phase, the lead man on the Air Force side of the program would be Capt. Iven Kincheloe, who was a five-victory jet ace from the Korean War, and obviously someone well suited to evaluate a new fighter aircraft.

The Air Defense Command was very keen on the F-106A from the beginning. Having acquired an even 1,000 F-102As, they made



A comparative photo of the third F-106A (left) and an F-102A taken on or about 4 December 1957 when the Delta Dart was undergoing flight tests at Edwards AFB and the Delta Dagger was already in service with Air Defense Command squadrons. As Convair pointed out in a contemporary press release, "Notable external differences between the two aircraft are found in the vertical stabilizers, engine air inlet ducts and in the optimum wasp-waisting of the F-106A fuselage...The vertical fin on the F-106A is swept back and squared off at the tip [while] the F-102A vertical fin is delta shaped. Incorporation of the larger- diameter J75 turbojet engine in the F-106A eliminated a need for the fairings built into the aft end of the F-102A fuselage to conform to the drag reducing Area Rule. Air intake ducts are shorter on the F-106A than on the F-102A, chiefly to save weight and to effectively control the flow of air to the J75 engine. The delta wing leading edges of both aircraft are cambered (curved downward) to help reduce drag and increase speed and climb performance at transonic speeds." (Convair via Author's collection)

plans for a like number of F-106As to equip a total of 40 squadrons. However, the apparent success of the aircraft during its earlier flights was not borne out during Category II flight testing. After more than 70 test flights of the first two aircraft, the Category II final report stated that both the aircraft's acceleration and maximum speed were below Convair's estimates. Specifically, under standard conditions, the F-106A took almost 270 seconds to accelerate from Mach 1 to Mach 1.7, and another 150 seconds to accelerate to Mach 1.8. This consumed 2,000 pounds of fuel in seven minutes. Because of this sluggish performance, the aircraft was not considered "tactically usable" at speeds greater than Mach 1.7.

A walk-around three-quarter front view of the third F-106A at Edwards AFB. The initial test flights of the early Block One aircraft took place during the first half of 1957. (Convair via Author's collection)

To rectify these shortcomings, Convair engineers proposed a series of upgrades. These included modifications to the inlet duct cowling and charging ejectors to maximize airflow to the J75-P-9 engine and boost speed as well as acceleration. Meanwhile, the project was also running behind schedule because of production delays with the J75-P-9 itself.

In parallel with the engine issues, one of the first major weaknesses to be noted with the F-106A was a fuel starvation problem that led to the possibility of a flameout, which was rather high on the scale of concern when it came to defects.

Based on the Category II recommendations of Capt. Kincheloe and Project Engineer Willie Allen, Convair engineers proposed solutions, and the Air Force signed off but, in the meantime, new dilemmas were cropping up in the cockpit. There were development problems with the ejection seat, which the Category II findings determined to be inadequate for use at supersonic speeds. Attempts to redesign it led to the overly complex Upward Rotational Ejection Seat. The issue was left unsolved until most F-106As had been delivered. The two-seat system required for the F-106B took even longer than that for the F-106A because of the dual timing system. (If two people ejected simultaneously, they would probably hit one another.) Indeed, rocket sled tests did not get underway until the middle of 1960.

Next, there was the control stick. The idea of moving the stick to the side so that the pilot could better see the Horizontal Situation Indicator had seemed like a good idea on paper, but in reality it was not so good. The Air Force had decided that the stick should be

Continuing the walk-around to a three-quarter rear view of the third F-106A, parked on the bone-dry lakebed at Edwards AFB. (Convair via Author's collection)

relocated to the center of the cockpit as it is in most fighter aircraft. It was moved, and also redesigned in the shape of the yoke used on transport aircraft, with flight control on one side and radar control on the other. This decision to center the stick, while being the correct one, only caused further delays, and resulted in cost overruns. Coincidentally, the side-mounted stick concept would be revisited again a generation later in another General Dynamics product, the F-16 Fighting Falcon.

Within the cockpit, such complexities and difficulties, as large as they were, paled by comparison to all that was involved in the Hughes MA-1 AWCS electronic control system. Reliability remained elusive as technicians battled to troubleshoot an electronic system that was so new and so sophisticated. The MA-1 comprised many things beyond just fire control, including automatic direction finding, the communication receiver and transmitter, countermeasures systems, and the gyrocompass. It was officially referred to as "the most complex, sophisticated, and completely integrated automatic weapon control system" yet designed for an aircraft of this type. Comprising 170 "black boxes," it weighed about 1,800 pounds. Naturally, the same computing power today would fit in the palm of your hand, but in the late 1950s this was at an extreme forward place within the state of the art.

All of these delays and difficulties would consume most of 1958 to resolve and Category II testing would not be concluded until June 1959. During this time, the aircraft was tested in conjunction with its fully integrated weapons system, including the MA-1 AWCS, at Holloman AFB in New Mexico. During these flights, inert Genies, as well as GAR-3A and GAR-4 Super Falcons, were test fired by Delta Darts. The first shootdown of another flying machine by a Delta Dart came in a demonstration at Holloman AFB in May 1960, when F-106A pilot Maj. J. D. Fowler splashed a TM-61 Matador surface-launched cruise missile using a pair of GAR-3A Super Falcons. Other such "aerial victories" were to be scored in subsequent encounters throughout the Delta Dart's career, although the F-106A would never achieve a true aerial victory over an actual enemy aircraft.

The first F-106A, in its light gray Air Defense Command war paint, during an early test flight. (Convair via Author's collection)

A helicopter hovers over the first F-106A, painted in overall light gray Air Defense Command livery and parked on the paved ramp at Edwards AFB. (Convair via Author's collection)

A Block 90 F-106A on its delivery flight, circa late 1959. The Delta Darts were now rolling out of the San Diego factory with their "FE" buzz numbers as part of their livery. Air Force crews later added their own individual squadron shields and unit insignia. (Convair via Author's collection)

The deadly offensive armament of the F-106A is seen here at Holloman Air Development Center in New Mexico in July 1959. From left, they are the Douglas MB-1 Genie, America's first air-to-air nuclear-armed rocket, and four GAR-3 Super Falcon guided missiles. As the Air Force described it in a contemporary press release, the Genie "vastly increases NORAD's capability to repel and destroy an enemy bomber force. The new Falcon missile, produced by Hughes Aircraft Company, has a longer, higher and deadlier reach than any other air-to-air guided missile. The F-106 weapon system may employ either the atomic rocket or GAR-3s in carrying out its air defense mission at speeds twice that of sound." (U.S. Air Force)

Air Force Capt. Iven Carl "Kinch" Kincheloe was a key figure in the development of the F-106 as a successful operational aircraft. A Korean War ace, he was well respected as a true "fighter pilot's fighter pilot." Kincheloe went on to serve as a test pilot on numerous programs, including the rocket-powered Bell X-2, which he flew to a record altitude of 126,000 feet. He was scheduled to become the Chief Air Force Test Pilot for the hypersonic North American X-15 rocketplane and had already been selected as an Air Force astronaut for the Man In Space Soonest project when he was killed in the crash of an F-104A at Edwards AFB in July 1958. Kincheloe AFB, later an F-106 base located in the Upper Peninsula of Michigan, was fittingly renamed in his honor. (U.S. Air Force)

Meanwhile, pilots began to undergo F-106A armament training under the auspices of the Air Defense Command Interceptor and Missile School at Tyndall AFB in Florida.

Speaking of training, a high point for the Delta Dart program during 1958 was the debut flight of the first two-seat F-106B (tail number 57-2507) on 9 April. The Air Force promptly accepted the type and the first production aircraft flew in October. By the end of the year, the first nine F-106Bs had been delivered and some would join the F-106As being tested at Holloman AFB. The F-106B, however, would not reach its initial operational capability (IOC) until July 1960.

With costs rising and delays mounting, the U.S. Air Force was growing pessimistic about the program during 1958. Its earlier high priority was downgraded, and the Air Force began to speak seriously of canceling the F-106A with the 120 aircraft that had already been funded. The Pentagon bean counters asked the Air Defense Command to consider choosing between terminating the F-106A and ending production of the F-101B, the interceptor variant of the McDonnell Voodoo. The latter had a top speed of about Mach 1.7 and a combat ceiling of 50,000 feet, slightly less than that intended for the F-106A, but its combat radius, rated at 600 nautical miles, was considerably greater than was planned for the Delta Dart.

Obviously, the Air Defense Command made the case for no cuts in either program and, amazingly, Air Force Headquarters backed down and agreed to keep both programs. However, the Air Defense Command was mandated to reduce its ambitious 40-squadron F-106A wish list to just 26. In the face of such rationing, the Air Defense Command would later make the decision to convert nearly three-dozen F-106A test aircraft to operational condition.

Even as continued production of the aircraft was assured, the program continued to be buffeted by delays. (Using such a term, which suggests choppy turbulence, is intentional.) The F-106A program moved in fits and starts through 1958 and the following years. Testing revealed "issues" and the issues required engineering changes. These were important and necessary, but they interrupted both production and flight testing. Every engineering change needed to be "defined, engineered, reviewed, and approved for production" in order for the assembly line to move.

Because of the relative shortage of aircraft, Category III flight testing would be delayed and it would coincide with the initial deployment to operational Air Defense Command units. In fact, the first squadron deliveries came in May 1959, to the 498th Fighter Interceptor Squadron, two months before Category III testing would begin. Some testing was done by an operational Air Defense Command unit, the 539th Fighter Interceptor Squadron at McGuire AFB in New Jersey, which was the first such unit to receive the F-106A.

The rationale of the Cook-Craigie Plan had always been to get new aircraft types into service as quickly as possible, and this generally played out as expected. It was anticipated that engineering changes could be made on the assembly line but, as with the YF-102, the changes to the F-106A were far more than had been foreseen.

A good example of how production outpaced systems development was the Delta Dart's ejection seat. As noted earlier, Convair had been working for years to develop the ultimate seat to complement the Ultimate Interceptor. The goal had been a high-altitude, supersonic ejection seat that would function safely at slower speeds—and at any altitude. The Convair Upward Rotational Ejection Seat, which literally rotated the pilot upward and then to a horizontal position outside the airplane, was a complex and elusive piece of equipment. Along with ejection seats for the Republic F-105 and North American X-15 rocket plane, it was one of the first American escape systems expressly designed for successful ejection at supersonic speeds. The quest for this perfect seat was to prove so elusive that it was not ready until late in 1960, when only 37 F-106As were left on the assembly line, and it had to be retrofitted to the nearly 300 F-106As and F-106Bs that were already in service.

The first test of the Upward Rotational Ejection Seat, known as the "Convair B," took place in June 1961. Though the test was successful, many later operational ejections were not, costing the lives of Air Force pilots. The design of the Convair B, like many other attempts at "perfect" supersonic ejection seats during this period, involved having the pilot encapsulate himself within the sled-like seat before firing the thruster. The myriad and complex collection of moving parts meant that there were a multitude of things that could go wrong. In 1965, the Convair B seat was withdrawn and replaced by a simpler and more reliable traditional ejection seat with enhanced "Zero-Zero" capability that was developed by Weber Aircraft. The Zero-Zero seat took its name from the fact that it could be used safely (at least theoretically) down to zero altitude and zero speed.

Because the engineering changes came in stages, few, if any, F-106As incorporated them all. By the time Category III testing ended in early 1961, the phrase "no two alike" generally described the F-106A fleet. You could find a few here or there that had identical configurations, but there were so many different types and sub-types that it was hard to keep them straight. Four of the first seven production blocks had eight or fewer aircraft in them, and Block 65 (the third block) had just three aircraft, at least one of which was used as a YF-106C concept-evaluation aircraft.

In fact, by the time Category III testing ended, the production line in San Diego had been closed for half a year. The last 62 F-106As and the last 15 F-106Bs had rolled out the doors at Lindbergh Field during the second half of calendar year 1960. The peak of production was reached during the previous 12 months. Between June 1959 and June 1960 (Fiscal Year 1960), 150 F-106As and 36 F-106Bs were built by Convair, representing 55 percent of all Delta Darts.

The flyaway cost of each F-106A aircraft was calculated at about \$4.7 million (about \$27 million in current dollars) and three times the price of the F-102A. Of course, Delta Daggers were ordered in about three times the quantity as the Delta Dart, and big numbers always result in lower unit costs. Of this total, about 45 percent was the cost of the airframe, 28 percent went to armament, and 6 percent represented the engine. Relative to the proportions in the F-102A program, the armament was a bigger slice of the pie, and the engine less. Each F-106B, meanwhile, cost \$4.9 million, with the proportions being roughly the same.

The first F-106B combat-capable Delta Dart trainer on the ramp at Lindbergh Field in San Diego on 17 February 1958. Note the unpainted F-102As parked in the background. (Convair via Author's collection)

Wearing street shoes and stylish socks, the flight crew boards the first F-106B at Lindbergh Field. (Convair via Author's collection)

Ready for flight: The first of the line of F-106B trainers made its maiden flight on 9 April 1959. (Convair via Author's collection)

Testing the complex and trouble-plagued Convair "B" Upward Rotational Ejection Seat. Designed for escape at supersonic speeds, the "Bobsled" seat was not given formal approval until late in 1960, but the overall complexity of the seat caused numerous problems and operational failures. Standard ejection seats eventually replaced this device in operational F-106As. (U.S. Air Force)

The bustling F-106A production line at Convair's San Diego facility: Center fuselage sections are coming together in the foreground while engine air intake sections are being fabricated at upper right. This was a time period that was literally the heyday of American aviation manufacturing. It was also an era that marked this country's dominance of aviation prowess throughout the world. (Convair via Author's collection)

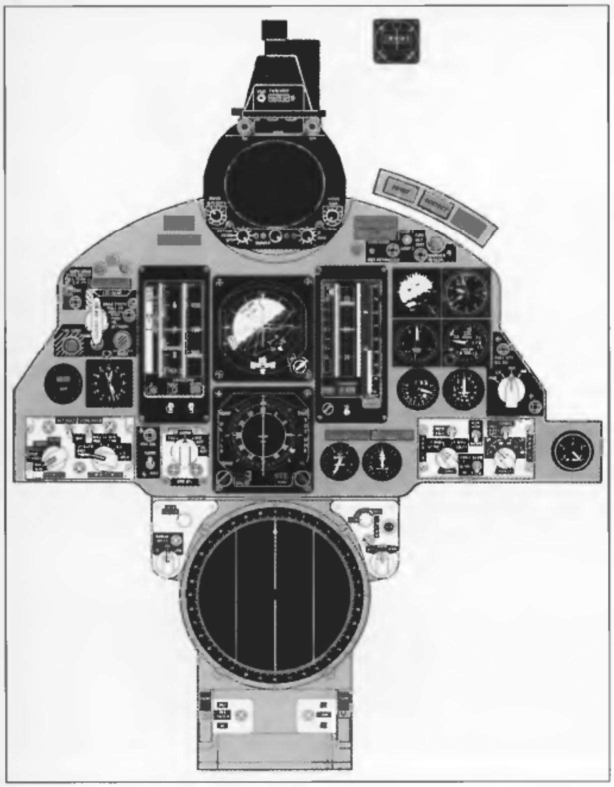
In the foreground, completed tail sections are mated with center fuselage sections. Behind, noses are added and canopies are then installed. (Convair via Author's collection)

The Delta Dart assembly line in San Diego at the midpoint of the production program. Aircraft number 124 rolled out late in 1960. (Convair via Author's collection)

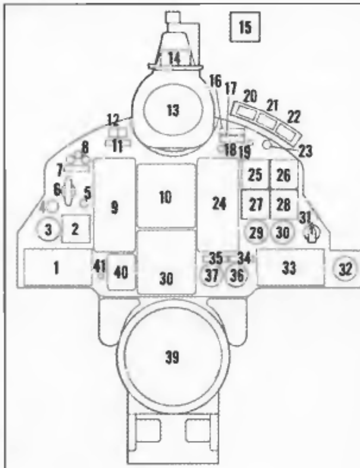
FISCAL YEAR USAF ACCEPTANCE RATES FOR OPERATIONAL DELTA DARTS

Year	F-106A	F-106B
1957	2	0
1958	16	1
1959	45	11
1960	150	36
1961	62	15

Postwar "Rosie the Riveters" at work in the Electrical Wiring Section above the F-106A assembly line. Installing the miles of analog wiring was a complex proposition that was obviously well organized. (Convair via Author's collection)

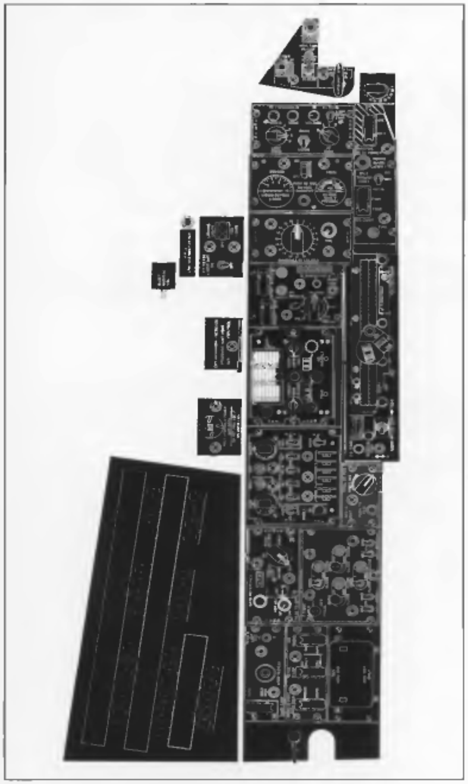


The Pilot's Center Cockpit Console Panel in the F-106A. (Courtesy of Patrick J. McGee)



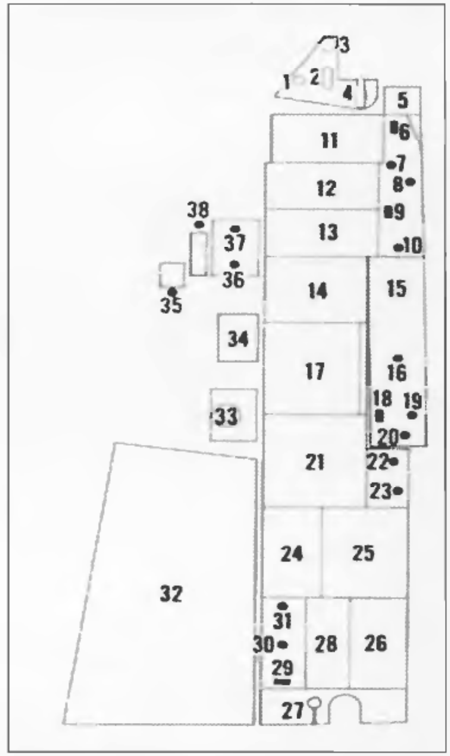
1. Flight Modes Panel
2. Clock
3. UHF Remote Indicator
4. Tail Hook Down Button and Light
5. Computer Mode Indicator
6. Drag Chute Handle
7. Landing Gear Warning Light
8. Landing Gear Position Lights
9. Airspeed Mach Indicator (AMI)
10. Attitude Director Indicator (ADI)
11. Maximum Maneuver Warning Light
12. External Tank Empty Lights
13. Radar Scope
14. Radar Scope Recorder
15. Standby Compass
16. Master Warning Light
17. Engine-Fire Warning Light
18. Variable Ramp Warning Light
19. Engine-Fire Warning Test Switch
20. Air Refueling Ready Light
21. Air Refueling Contact Light
22. Air Refueling Disconnect Light
23. Marker Beacon Light
24. Altitude Vertical Velocity Indicator (AVVI)
25. Standby Attitude Indicator
26. Standby Altimeter
27. Standby Airspeed Indicator
28. Engine Pressure-Ratio Gauge
29. Exhaust-Gas Temperature Gauge
30. Tachometer
31. Fuel Quantity Gauge Selector Switch
32. Nucleonic Oil Quantity Indicator
33. Radar/IR Selector Panel
34. Hydraulic Pressure Low-Warning Light
35. Canopy Unlocked Warning Light
36. Fuel Flow Indicator
37. Fuel Quantity Gauge
38. Horizontal Situation Indicator (HSI)
39. Tactical Situation Display (TSD)
40. Bearing Selector Switch
41. Heading Selector Switch

A key to the Pilot's Center Cockpit Console Panel in the F-106A. (Courtesy of Patrick J. McGee)



The Pilot's Left Cockpit Console Panel in the F-106A. (Courtesy of Patrick J. McGee)

1. *Landing Gear Emergency Up Button*
2. *Landing Gear Handle*
3. *External Wing Tanks Release Button*
4. *Landing Gear Emergency Extension Handle*
5. *Altitude Band Switch*
6. *Master Electrical Power Switch*
7. *Landing Gear Audio Warning Cutoff Button*
8. *Idle Thrust Control Switch*
9. *CG Control Switch*
10. *CG Transfer Test Failure Light*
11. *Radar/IR Control Panel*
12. *Oxygen Control Panel*
13. *ILS Channel Selector Panel*
14. *Armament Control Panel*
15. *Throttle Quadrant*
16. *Throttle*
17. *Communications Frequency Selector Panel (UHF)*
18. *Takeoff Trim Light*
19. *Fuel Control Switch*
20. *Rudder Trim Switch*
21. *IFF Control Panel*
22. *Mask Defog Rheostat*
23. *Anti-G Suit Test Button*
24. *MA-1 Power Control Panel*
25. *Fuel Control Panel*
26. *MA-1 Test Panel*
27. *Cabin Air Selector Handle*
28. *Air Refueling Panel*
29. *Variable Ramp Switch*
30. *Armament Recycle Button*
31. *Pitch G Limit Test Switch*
32. *Cockpit Left Fuse Panel*
33. *Ram Air Turbine (RAT) Handle*
34. *Pressure Suit Control Handle*
35. *Reset/MBL Switch*
36. *Cockpit No-Fog and Ventilated Suit Switch*
37. *Landing and Taxi Light Switch*
38. *AIR-2A Arm/Safe/Monitor Power Circuit Breaker*



A key to the Pilot's Left Cockpit Console Panel in the F-106A. (Courtesy of Patrick J. McGee)

UNPRODUCED DELTA DART VARIANTS

As the F-106A and F-106B were in production during the late 1950s, Convair proposed its Model 8-28 and 8-29 Delta Darts, which were studied by the U.S. Air Force, which considered their acquisition under the designations F-106C and F-106D. The F-106D was proposed as a two-seat-trainer version of the F-106C. They would have differed from the F-106A and F-106B in that they would have had a structurally revised fuselage and internal changes such as the new 40-inch radar with "look-down, shoot-down" capabilities. Though this system would have reduced, albeit slightly, the altitude and combat radius, it would reportedly have substantially increased the F-106C/D's "kill probability" by enlarging its search range by a minimum of 50 percent. The F-106C and F-106D were to have been powered by the Pratt & Whitney JT4B-22 engine, an improved variant of the commercial JT4A axial-flow turbojet that was used in first-generation jetliners such as the Boeing 707 and Douglas DC-8. The military version of the JT4A engine, designated J75, powered the F-106A and F-106B.

The Air Force originally considered ordering 350 F-106Cs, but canceled the variant in September 1958, a couple months before the two YF-106C prototypes were delivered. After being evaluated, one of them was destroyed in fatigue testing, and the other was reconfigured as an F-106A and delivered to the New Jersey Air National Guard. Planning for an F-106D variant had not evolved very far when the Air Force decided in 1958 to cap the Delta Dart program with the F-106As and F-106Bs then on order.

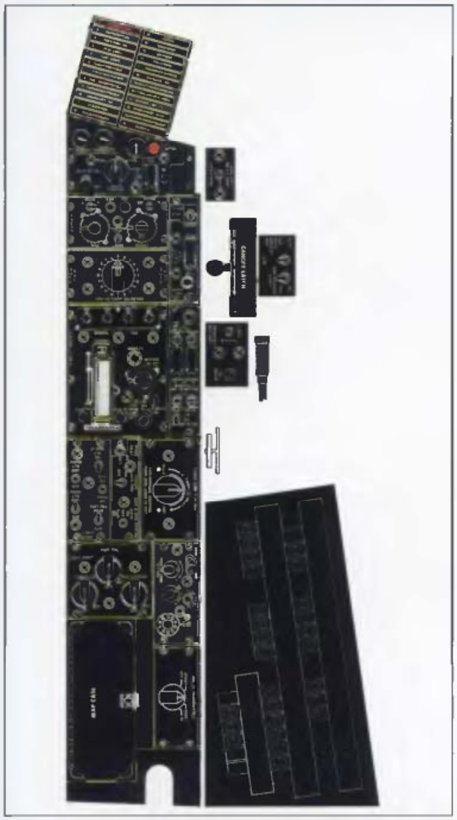
A decade later, Convair unsuccessfully proposed to reopen the Delta Dart assembly line for a new F-106E and/or F-106F series with improved radar systems. As with the Delta Dagger, Convair also proposed an attack variant of the Delta Dart. However, the Air Force showed no serious interest in having an F-106 fighter bomber. The newer two-seat, twin-engine McDonnell F-4 Phantom, on the other hand, possessed a ground-attack capability among its other attributes, and emerged as the Air Force's new multi-role tactical aircraft.

Delta Dart 61-0630 was never built, but was a proposal in model form for an advanced aircraft with delta canard wings attached to the forward fuselage. No F-106 aircraft were known to have been ordered in Fiscal Year 1961. Pushed forward, the intakes are more like those of the F-102 Deuce than of the Dart. (Convair via Robert Bradley)

Looking like a 1950s-era Marx playset, this model contains not only a 1/32-scale F-106A, but all of the ground support and armament equipment associated with it, including oxygen cylinders, auxiliary power units, Falcon missiles, arrestor cables, and even an Oshkosh O-11-type fire truck. (Author's collection)

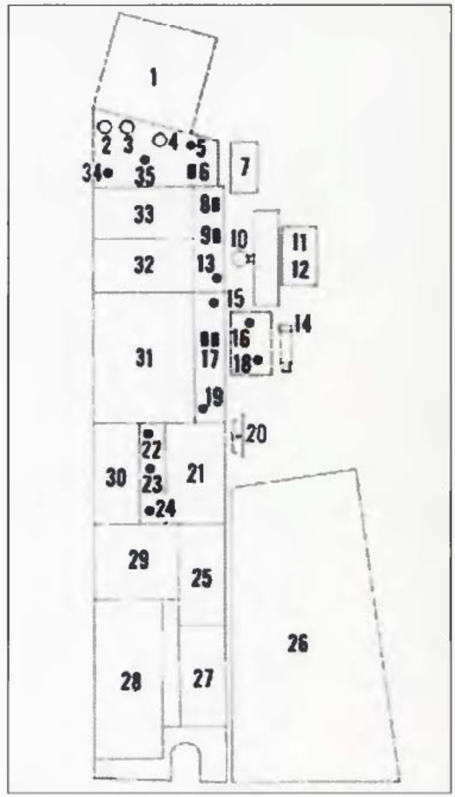
This long-nosed YF-106C served as a radar testbed. It was later restored to F-106A configuration. (Hughes via Terry Panopalis)

A detail view of the F-106A Delta Dart's speed brakes in the open position on the ramp at San Diego. (Convair via Author's collection)



The Pilot's Right Cockpit Console Panel in the F-106A. (Courtesy of Patrick J. McGee)

1. Master Warning Light Panel
2. Primary Hydraulic System Pressure Gauge
3. Secondary Hydraulic System Pressure Gauge
4. Oil Pressure Gauge
5. IFF Caution Light
6. Generator Switch
7. No. 3 Fuel Tank Switch
8. Canopy Switch
9. Data Link Antenna Switch
10. Canopy Latch Handle
11. ATG Switch
12. Map Reading Light Switch
13. Warning Lights Test Button
14. Map Reading Light
15. Engine Anti-Ice Warning Test Button
16. Emergency AC Generator Switch
17. Windshield Anti-Icing, Anti-Fog Switches
18. EGT Spread Button
19. Rain Removal Switch
20. Ejection Seat Ground Safety Pin Stowage
21. Cabin Temperature Control Knob
22. Pitot Heat Switch
23. Canopy Anti-Fog Switch
24. Surface and Engine Anti-Icing Switch
25. Compass Control Panel
26. Cockpit Right Fuse Panel
27. MATTS Switch
28. Map and Data Case
29. Lighting Control Powerstats
30. Lighting Control Panel
31. Data Link Control Panel
32. Auto-Navigation Homing Point Selector
33. TACAN Control Panel
34. Refrigeration Unit Switch
35. Cabin Air Selector



A key to the Pilot's Right Cockpit Console Panel in the F-106A. (Courtesy of Patrick J. McGee)

CHAPTER ELEVEN

INITIAL DEPLOYMENT OF THE F-106 DELTA DART

The lineage of the 94th "Hat in the Ring" Fighter Interceptor Squadron dates back to World War I, when Eddie Rickenbacker, America's "Ace of Aces," flew with the unit. Based at Selfridge AFB in Michigan, the squadron was operational with the F-106A from 1960 to 1969. (W. J. Balogh via David Menard)

In looking at the history of the Delta Dart program, it is easy to get sidetracked by the early problems of development and production. Yes, the program moved in fits and starts, but it can easily be argued that had it not been for Cook-Craigie, the F-106A would not have been ready for prime time in 1961. The development period had its ups and downs, but four-and-a-half years after the first flight of the F-106A, the Ultimate Interceptor was ready to report to duty.

The F-106A Delta Dart entered service almost simultaneously with two Air Defense Command units on opposite sides of the continental land mass that it was designed to protect, although exactly which side was first is the subject of ongoing discussion. The 498th "Geiger Tigers" Fighter Interceptor Squadron at Geiger AFB near Spokane, Washington, is reported to have received its first F-106As on 29 May 1959, although they may not have actually reached the base until 2 June. Meanwhile, the 539th "Iron Hand" Fighter Interceptor Squadron at McGuire AFB in New Jersey is confirmed to have received its F-106As by at least 30 May, with one aircraft possibly reaching the base as early as 17 April.

On 21 July, the 498th Fighter Interceptor Squadron conducted what was probably the first simulated interception mission made by F-106As. Five interceptors were scrambled, locating and destroying their intended "targets" within 10 minutes of wheels-up at Geiger.

The third unit to receive its Delta Darts was the 95th Fighter Interceptor Squadron at Andrews AFB in Maryland on 17 July. Known as "Mr. Bones" because of the skeleton in a top hat on its squadron patch, the unit was tasked with providing interceptor coverage for nearby Washington, D.C. In 1963, Mr. Bones relocated about 80 miles northeast to Dover AFB in Delaware.

The staging of the activation of F-106A units within Air Defense Command units would be tied to the activation of SAGE centers in strategic corners of the United States. Two other Air Defense Command squadrons, again on opposite sides of the country, received the F-106A during the fall of 1959. The 456th Fighter Interceptor Squadron at Castle AFB in California received its aircraft on 16 September, and the 27th "Fighting Falcons" Fighter Interceptor Squadron at Loring AFB got its first Delta Darts a month later. Ten years later, on 13 May 1969, the Fighting Falcons would claim the distinction of being the first F-106As based in the contiguous United States to intercept Soviet bombers off the coast. Taking place 150 miles off the coast, this intercept involved two Delta Darts and three Dalnaya Aviatsiya Tu-95 Bears that were en route to Cuba on a routine mission. No shots were fired.

At the end of its first year of service, the F-106A was used to set a world's absolute speed record. On 15 December 1959, an F-106 piloted by Air Force Maj. Joe Rogers took off from Edwards AFB to clock 1,525.695 mph on an 11-mile straight course, beating a record of 1,483.84 mph set in 1956 by a Soviet Ye-66, an early variant of the Mikoyan-Gurevich MiG-21 that was specially designed to set the world speed record.

During 1960, eight more Air Defense Command squadrons, located strategically near population centers and across the northern

An F-106A in a hangar at Holloman AFB under the hot New Mexico sun. (Erik Simonsen)

Poised and ready for the "SCRAMBLE" call, this F-106A sits in its alert shack awaiting the order to launch at a moment's notice. (Author's collection)

tier of the United States, converted to the F-106A. The first was the 5th Fighter Interceptor Squadron on 30 January. Known as the "Spittin' Kittens" because of the salivating bobcat on their squadron patch, the 5th had been operating the F-102A at Suffolk County in New York, and made a very big change to Minot AFB in North Dakota as it converted to the F-106A.

Other fighter interceptor squadrons becoming operational with the F-106A during the years were the 11th "Red Bulls" at Duluth Airport in Minnesota, the 48th "Tasmanian Devils" at Langley AFB in Virginia, the 71st at Selfridge AFB in Michigan, the 318th at McChord AFB in Washington, the 319th at Bunker Hill AFB in Indiana, the 329th at George AFB in California, and the 438th Fighter Interceptor Squadron at Kincheloe AFB in Michigan.

Even as the Air Force was integrating the Delta Dart into its front-line fleet, NASA found the aircraft to be ideal for specialized needs. With the beginning of the Mercury manned-spaceflight program, pilots from the various services went on temporary duty with the space agency to train as astronauts. To support the flight proficiency requirements of astronaut training, the Air Force contributed

One of the first units to become operational with the F-106A, the 456th Fighter Interceptor Squadron at Castle AFB in California received their Delta Darts on 16 September 1959. (W. M. Jefferies via David Menard)

On 15 December 1959, at the end of the Delta Dart's first year of Air Force service, this F-106A (56-0467) was used to set the world's absolute speed record of 1,525.695 mph on an 11-mile straight course. Although bested by the Mach 3 Lockheed SR-71 Blackbird several years later, the F-106's record still stands as the fastest speed ever attained by a single-engined jet aircraft in level flight. (U.S. Air Force)

several T-33s, three F-102A Delta Daggers, an F-106A, and an F-106B. The latter joined NASA at the Langley Research Center in Virginia in 1961. Also in 1961, an F-106A was loaned to NASA's Ames Research Center at Moffett Naval Air Station in California for the study of air-to-air missile guidance and control. The results of the latter tests, which included the MA-1, ultimately benefitted the F-106 tactical program.

During the first year-and-a-half of F-106 deployment, the Air Defense Command had reason for concern that, after all the earlier teething troubles, the Delta Dart might *still* not be truly combat ready. There were complaints of fuel-combustion-starter failures, fuel-flow problems, and generator imperfections. In December 1959, when a canopy was jettisoned by accident while a Delta Dart was aloft, the whole F-106A fleet was ordered to be grounded.

Air Defense Command records compiled through the early part of 1960 enumerated problems that would necessitate 67 modifications to the airframe and 63 to the fire-control system that would have to be retrofitted and/or introduced on the rapidly progressing assembly line. Field retrofits, undertaken early in 1960, would be the responsibility of the Air Materiel Command (Air Force Logistics Command after April 1961) working with Convair technicians. The actual work would be done on site at Air Defense Command bases by Air Materiel Command field assistance teams, who would work with Air Defense Command ground crews.

During the summer of 1960, as the F-106A marked the first anniversary of its introduction into squadron service, the U.S. Air Force authorized two somewhat overlapping, somewhat contradictory, refurbishment programs for the Delta Darts. *Project Broad Jump* was an upgrade program, while *Project Wild Goose* was a broad-ranging program aimed at standardizing the fleet. By now, this fleet included a myriad of configurations because of all the retrofits and engineering changes to aircraft that ranged from recently delivered production aircraft to aircraft that had been delivered for flight tests back in 1957 and later modified to operational status.

Wild Goose was officially completed by the fall of 1961, but *Broad Jump* continued through early 1963. The latter program involved technicians from the Sacramento Air Materiel Area spending an average of 60 days working on each aircraft. During this process, the Air Defense Command maintained at least half of the F-106As at any given base on alert duty while the crews from Sacramento worked on the other aircraft.

Another upgrade program, called *Dart Board,* retrofitted the F-106A with a thermal flash-blindness-protection hood to protect the pilot after his MB-1 (AIR-2A after 1962) Genie nuclear missile struck a formation of Soviet bombers. *Dart Board* was undertaken in August 1961 and completed eight months later.

Among the other major upgrades that came during and after the years of *Broad Jump* and *Wild Goose* were systems to counter enemy

USAF Maj. Joseph W. "Whistlin' Joe" Rogers was the pilot who set the world's absolute speed record in December 1959. At the time, the veteran combat pilot was project officer for F-106 integration at Air Defense Command Headquarters. He later commanded the 317th Fighter Interceptor Squadron at Elmendorf AFB, and still later headed the SR-71A/F-12A Test Force. His final U.S. Air Force assignment was as Chief of Staff for Operations at Aerospace Defense Headquarters. (U.S. Air Force)

This placard located in the cockpit of F-106A 56-0467 reminded future pilots of the historic moment. While assigned to the 329th Fighter Interceptor Wing several years later, this famous aircraft was lost when its right main tire blew out on takeoff from George AFB with pilot Ken Robken at the controls. The gear collapsed and the aircraft caught fire on the runway, but Robken luckily managed to escape before the F-106A was completely engulfed in flames. (Author's collection)

Hardly a "mouse" because of its gargantuan size, the long-range Tupolev Tu-9S turboprop bomber played that role opposite the F-106A "cat" in the cat-and-mouse games of high-altitude encounters through much of the Cold War. Code named Bear, the Tu-95 was the mainstay of the Soviet Union's long-range aircraft operations (Dalnaya Aviatsiya). (Department of Defense)

Based at Minot AFB on the remote northern plains of North Dakota, the "Spittin' Kittens" of the Air Defense Command's 5th Fighter Interceptor Squadron operated the F-106A for a quarter century, from 1960 to 1985. (U.S. Air Force)

electronic countermeasures. These included chaff launchers, parametric amplifiers, and pulse-to-pulse frequency shift systems.

As for offensive systems, by 1960 Hughes had developed and tested an infrared search-and-track sight capable of operating at low altitudes in an environment that would confuse radar with ground clutter. This system had evolved from the ASG-18 pulse-Doppler fire-control system that Hughes had developed for the North American Aviation F-108 interceptor that had been canceled in 1959.

On that note, I would like to digress for a moment for a few words on the F-108 Rapier and its relationship to the Air Defense Command interceptor philosophy in the 1950s. The F-106, once considered to be the Ultimate Interceptor, was essentially a "point-defense" interceptor. It had a modest combat radius and was designed to be based near the target it was tasked with protecting, whether that was a population or industrial center, or the coastline or perimeter of the continent. The F-108, on the other hand, was the culmination of the Air Defense

In 1961, the Air Force loaned a pair of Delta Darts to NASA, including this F-106B, for use in astronaut training. Seen here with an aircraft on 21 January 1961 at Langley AFB are the original seven famed Mercury astronauts. From left, they are Scott Carpenter, Gordon Cooper, John Glenn, Virgil "Gus" Grissom, Walter Schirra, Alan Shepard, and Donald K. "Deke" Slayton. (NASA)

Command's Long-Range Interceptor, Experimental (LRIX) program. Initiated in 1955, LRIX called for a stainless steel, twin-engine aircraft capable of flying at Mach 3 and at 70,000 feet, with a combat radius of 1,000 nautical miles. North American won the competition in 1957 and went as far as an F-108 mock-up before the program was canceled. The Lockheed YF-12A later filled the bill conceptually, but the U.S. Air Force never fielded a dedicated long-range interceptor.

The F-108 was gone, but Hughes continued to develop its ASG-18 fire-control system, which was designed to be integrated with the AIM-47 (originally GAR-9) Falcon long-range air-to-air missile. Eventually the AIM-47 evolved into the AIM-54 Phoenix that was deployed with the U.S. Navy's Grumman F-14 Tomcat fleet interceptor.

As the F-106A was entering service, it was going through the *Broad Jump* and *Wild Goose* upgrade programs, and as the aircraft served in Air Defense Command squadrons through the 1960s, further such modification procedures continued. In 1965 the Air Force authorized $6.2 million for new TACAN systems for the F-106A that reduced the weight of the original equipment by two thirds.

DART VERSUS PHANTOM

It has been postulated that a big part of the decision by the U.S. Air Force not to order more than 340 Delta Darts was the informal interpretation of the results of a test concluded on 17 November 1961 off the coast of Virginia. In this joint-service evaluation, called *Project High Speed*, the capabilities of the F-106A were evaluated against those of the Navy's new twin-jet, two-seat McDonnell F4H-1 (F-4B after 1962) Phantom II. Thanks to the superior performance of the Phantom's APQ-72 fire-control system, coupled with numerous malfunctions by the Delta Dart's MA-1, the F4H-1 was declared the winner.

However, a closer look at *Project High Speed* shows that no competitive missile firings took place, and that the declaration of the Phantom II as the winner was based largely on radar "lock-ons" achieved. In simulated air combat, the Delta Dart reportedly outmaneuvered the Phantom most of the time, but this was apparently not considered because dogfighting was not an important capability for fighter aircraft in 1961. The Air Force was yet to learn the bitter lessons of air-to-air combat over Southeast Asia.

In any case, the Air Force responded in December 1961 by ordering the Phantom for itself under the designation F-110A (F-4C after 1962), and the rest is history.

OPERATIONAL DELTA DART INTERCEPTOR SQUADRONS

2nd Fighter Interceptor Squadron "Unicorns," aka "Horny Horses" (ADC)
Wurtsmith AFB, Michigan, 1971–1972

5th Fighter Interceptor Squadron "Spittin' Kittens" (ADC)
Minot AFB, North Dakota, 1960–1985

11th Fighter Interceptor Squadron "Red Bulls" (ADC)
(Redesignated as the 87th Fighter Interceptor Squadron in 1968)
Duluth Airport, Minnesota, 1960–1968

27th Fighter Interceptor Squadron "Fighting Falcons" (ADC)
Loring AFB, Maine, 1959–1982

48th Fighter Interceptor Squadron "Tasmanian Devils" (ADC)
Langley AFB, Virginia, 1960–1982

49th Fighter Interceptor Squadron "Cavaliers" (ADC)
Kincheloe AFB, Michigan, 1968–1987

71st Fighter Interceptor Squadron (ADC)
Selfridge AFB, Michigan, 1960–1967
Richards-Gebaur AFB, Missouri, 1967–1968
Malmstrom AFB, Montana, 1968–1971

83rd Fighter Interceptor Squadron (ADC)
Loring AFB, Maine, 1971–1972

84th Fighter Interceptor Squadron "Black Panthers" (ADC)
Hamilton AFB, California, 1968–1977
Castle AFB, California, 1977–1981

87th (formerly 11th) Fighter Interceptor Squadron "Red Bulls" (ADC)
Duluth Airport, Minnesota, 1968–1971
K. I. Sawyer AFB, Michigan, 1971–1985

94th Fighter Interceptor Squadron "Hat in the Ring" (ADC)
Selfridge AFB, Michigan, 1960–1969

95th Fighter Interceptor Squadron "Mr. Bones" (ADC)
Andrews AFB, Maryland, 1959–1963
Dover AFB, Delaware, 1963–1973

101st Fighter Interceptor Squadron (Massachusetts Air National Guard)
Otis AFB (Otis ANGB after 1973), 1972–1988

119th Fighter Interceptor Squadron "Jersey Devils" (New Jersey Air National Guard)
Atlantic City Airport, 1972–1988

159th Fighter Interceptor Squadron (Florida Air National Guard)
Jacksonville Airport, 1974–1987

OPERATIONAL DELTA DART INTERCEPTOR SQUADRONS CONTINUED

171st Fighter Interceptor Squadron "Six Pack" (Michigan Air National Guard)
Selfridge AFB, 1972–1978

186th Fighter Interceptor Squadron (Montana Air National Guard)
Great Falls Airport, 1972–1987

194th Fighter Interceptor Squadron (California Air National Guard)
Fresno Airport, 1974–1984

318th Fighter Interceptor Squadron (ADC)
McChord AFB, Washington, 1960–1983

319th Fighter Interceptor Squadron (ADC)
Bunker Hill AFB, Indiana, 1960–1963
Malmstrom AFB, Montana, 1971–1972

329th Fighter Interceptor Squadron (ADC)
George AFB, California, 1960–1967

437th Fighter Interceptor Squadron (ADC)
Oxnard AFB, California, 1968–1968

438th Fighter Interceptor Squadron (ADC)
Kincheloe AFB, Michigan, 1960–1968

456th Fighter Interceptor Squadron (ADC)
Castle AFB, California, 1959–1968

460th Fighter Interceptor Squadron (ADC)
Oxnard AFB, California, 1968–1974

498th Fighter Interceptor Squadron "Geiger Tigers" (ADC)
Geiger AFB (Spokane International Airport after 1960), Washington, 1959–1963
McChord AFB, Washington, 1963–1968

539th Fighter Interceptor Squadron "Iron Hand" (ADC)
McGuire AFB, New Jersey, 1959–1967

Notes:
(1) The Air Defense Command (ADC) became the Aerospace Defense Command (ADC) on 15 January 1968.
(2) All interceptor squadrons were transferred from the Aerospace Defense Command to the Tactical Air Command during 1979. Fighter Interceptor Squadrons were eventually redesignated as Tactical Fighter Squadrons.

OTHER U.S. AIR FORCE DELTA DART USERS

2nd Fighter Interceptor Training Squadron (ADC)
Tyndall AFB, Florida

319th Fighter Interceptor Training Squadron (ADC)
Tyndall AFB, Florida

418th Test Squadron (Air Materiel Command)
Edwards AFB, California

4750th Test Squadron (ADC)
Tyndall AFB, Florida

4756th Air Defense Group (ADC)
Tyndall AFB, Florida

4756th Air Defense Squadron (ADC)
Tyndall AFB, Florida

4757th Air Defense Squadron (ADC)
Tyndall AFB, Florida

475th Test Squadron (ADC)
Tyndall AFB, Florida

4786th Test Squadron (Air Force Systems Command)
Edwards AFB, California

4786th Test Squadron (ADC)
Edwards AFB, California

62nd Fighter Interceptor Training Squadron (ADC)
Tyndall AFB, Florida

6510th Test Wing (Air Research & Development Command)
Edwards AFB, California

6511th Test Group (Air Research & Development Command)
Edwards AFB, California

6520th Test Group (Air Research & Development Command/Air Force Systems Command)
Hanscom AFB, Massachusetts

73rd Air Division (ADC)
Tyndall AFB, Florida

Arguably the most important mid-1960s modification was retrofitting the Delta Dart fleet with the capability of being refueled in flight. This was undertaken more with the idea of long ferry flights than operational missions, but it gave the Delta Dart essentially unlimited range. At the same time, external fuel tanks capable of withstanding supersonic speeds were designed and introduced. Unlike the F-102A, however, the F-106A was rarely deployed outside the continental United States.

In December 1967, aerial refueling supported a nonstop, transcontinental F-106A mass deployment from McChord AFB to Tyndall AFB in what the Air Defense Command billed as "the first extended-range interceptor flight marked by inflight refueling and missile firing."

In terms of temporary tactical deployments within North America, the Delta Dart would be no stranger to Alaska during its long career with the Air Defense Command. In July 1963, aircraft from the 318th and 498th Fighter Interceptor Squadrons at McChord AFB in Washington were rotated north to support Alaskan Air Command F-102A operations under the operational code name *White Shoes.* Three months later, the Delta Darts conducted their first live intercept of a pair of Soviet Tupolev Tu-16 Badger bombers probing the Alaskan Air Defense Identification Zone (ADIZ) over the Bering Sea. *White Shoes,* later renamed *College Shoes,* included an ongoing, if technically "temporary duty," presence of Delta Darts in Alaska. During this time, there were numerous instances of F-106s intercepting—albeit not firing upon—Soviet aircraft, which always turned away when identified. The cat and mouse game continued through the decade and beyond.

The *College Shoes* deployments of Delta Darts to Alaska were an early example of forward deployment of Aerospace Defense Command assets, and they provided the prototype for *College Cadence,* a Command contingency plan to send F-106 contingents to trouble spots around the world. One of the first *College Cadence* deployments was also an early exception to the practice of the Delta Dart being kept close to its North American home. This came in March 1968, during the build-up of U.S. forces in South Korea in the wake of the North Korean seizure of the surveillance ship USS *Pueblo,* which had occurred the previous January. F-106As that deployed out of McChord AFB for this mission were the first Delta Darts supported by aerial refueling for a non-stop, transoceanic mission.

A Block One F-106A gets shoveled out after a January 1959 snowstorm at Eielson AFB near Fairbanks, Alaska. This aircraft ended its career as a QF-106 drone that was shot down by an advanced AIM-120 AMRAAM air-to-air missile over Tyndall AFB in 1997. (Author's collection)

One of the longest serving Delta Dart units, the 318th Fighter Interceptor Squadron at McChord AFB in Washington operated the aircraft from 1960 to 1983. In July 1963, the squadron contributed aircraft to the White Shoes deployment of interceptors in support of Alaskan Air Command F-102As. (U.S. Air Force)

THE F-106 DELTA DART MATURES

F-106As over Mount McKinley during an Operation College Shoes deployment to Alaska in April 1969. College Shoes, like White Shoes before it, saw fighter interceptor squadrons from the Lower 48 sent to Alaska on a rotational basis. In the foreground is an aircraft of the 87th Fighter Interceptor Squadron "Red Bulls" (formerly the 11th Fighter Interceptor Squadron) out of Duluth, Minnesota. Behind is a pair of F-106As from the 48th "Tasmanian Devils" Fighter Interceptor Squadron, based at Langley AFB in Virginia. (U.S. Air Force)

As had been the case with the F-102A, the Air Defense Command had not planned on a long career for the F-106A. In the case of the Delta Dagger, it went from being the most numerous interceptor in the command in 1958 to one third of its peak numbers within three years. During the 1950s and early 1960s, Air Force hardware acquisitions were governed by the idea that rapidly changing technology made—and would continue to make—existing aircraft obsolete in relatively short order. During World War II, the state of the art had gone from 250-mph piston-powered fighters to 500-mph jets in only six years, and during the 1950s and early 1960s, the top speeds of jet fighters had gone from subsonic to triple-sonic. Against these facts, it was logical to reason that even the Ultimate Interceptor may not be the best of its class for more than a few years.

Again, as had been the case when the F-102A was being developed, the Air Defense Command was planning for a Delta Dart replacement even before all the intended squadrons received their aircraft. Various aircraft were studied under the Advanced Manned Interceptor (AMI) program, including the Lockheed YF-12A interceptor and an Air Force variant of the F-14A Tomcat that Grumman was developing for the Navy. The YF-12A was part of the super-secret family of very-high-altitude Mach 3-plus reconnaissance aircraft that began with the CIA's A-12 Oxcart and went on to include the SR-71 Blackbird.

In the late 1960s, as an alternative to the expensive Lockheed interceptor, Convair proposed a concept provisionally designated as F-106X that would have involved a greatly upgraded Delta Dart. In 1969, F-106X development costs were estimated at $626.2 million, which would be $3.2 billion in current dollars. In the end, neither the F-106X nor the AMI program came to fruition. The U.S. Air Force had preferred an operational F-12B, but Secretary of Defense Robert McNamara did not, and Congress disapproved of the cost of any alternative. In the face of this, the Air Force would retain and improve the F-106A that it already had.

The Air Defense Command officially became the Aerospace Defense Command on 15 January 1968, the designation that it would retain until its deactivation and merger into the Tactical Air Command 12 years later. The new designation represented the new image that the Air Force had of itself, that of a force that was soon to expand its sphere of operations into outer space. Already in production were the first of several Manned Orbiting Laboratories (MOL). The Air Force had conceived the MOL space stations as a means of giving it a permanent presence in space. Air Force crews would have flown into space aboard "Blue Gemini" space capsules, which were to have been variants of NASA's Gemini spacecraft built for the Air Force and launched from Vandenberg AFB in California. Though MOL was canceled in June 1969 before its first deployment, the Air Force would still take seriously the idea of space as a theater of operations.

Back within the earth's atmosphere, however, the primary role of the Aerospace Defense Command was still the air defense of North America, and the key part of this was still an air-breathing interceptor. With the F-12B out of the picture, the Aerospace Defense Command realized that the F-106A was going to be its "ultimate" interceptor for the foreseeable future. With this in mind, the command considered numerous potential upgrades to its Delta Dart fleet.

One such program was the Simplified Logistics and Improved Maintenance (SLIM) program that had been submitted for approval in 1967, but rejected by Air Force Headquarters because of the $120 million cost.

In 1969, a less expensive alternative to SLIM was proposed. This was the Minimum Essential Improvement in System Reliability project that carried the acronym MEISR, which can be pronounced "miser," thereby suggesting that the program would pinch pennies. Approved by the Air Force, the MEISR program provided improvements to the automatic flight control, power, and radar systems of 250 F-106A and F-106B aircraft. The actual work was done by Air Force Logistics Command teams at Hamilton AFB in California under the support of the 4661st Air Base Group. The aircraft were rotated through Hamilton a few at a time so as not to interrupt alert schedules.

A proposal that the Aerospace Defense Command entertained (in the wake of lessons being learned the hard way over North Vietnam) was to arm the F-106A with a General Electric M61A1 Vulcan rotary-barreled, 20mm cannon. The idea was spearheaded by Brig. Gen. James Price, who had been a wing commander during the Korean War, and who understood aerial combat firsthand. McDonnell Douglas was already incorporating such a weapon into the F-4E variant of its Phantom II air-superiority fighter. McDonnell had originally designed the Phantom II under the same theory that Convair had designed the Delta Dagger and Delta Dart, that the future of aerial

A two-seat F-106B assigned to the 101st Fighter Interceptor Squadron of the Massachusetts Air National Guard, based at Otis AFB. It is October 1969, and as can be seen on the billboard, the aircraft is deployed to the Air Defense Weapons Center at Tyndall AFB in Florida. (U.S. Air Force)

combat was missiles. Over Southeast Asia, however, Phantom pilots in F-4Cs and F-4Ds found that guns were still essential for dogfighting, and an external 20mm gun pod was attached to give these earlier Phantom variants that capability. McDonnell (McDonnell Douglas after April 1967) then designed the F-4E with an internal gun.

The idea was not that the Aerospace Defense Command would use the F-106A in dogfights, but that there might be intercept situations where the Delta Dart would be involved in close-in fighting with Soviet fighters or bombers. Arming the F-106A's missiles took time, while guns were available at the touch of a button.

From a design point of view, the F-106A gun was to have been produced within a module that could be plugged into the internal weapons bay that otherwise held the MB-1 (AIR-2A after 1962) Genie nuclear-armed rocket. This way, the F-106A could carry the AIM-4 Falcons *plus* either a gun or a Genie. Hand-in-hand with the cannon capability, Convair and the Aerospace Defense Command considered retrofitting gun-armed F-106As with a cockpit canopy that afforded the better visibility that is craved by pilots involved in a dogfight.

Under a program known as *Project Six Shooter* (a double pun, given that the F-106A was nicknamed "the Six"), one F-106A (tail number 58-0795) was sent to Tyndall AFB for conversion in February 1969. A second F-106A joined the program in 1972 after the first *Six Shooter* F-106A had flown 20 test missions in which it opened fire on target drones. Several F-106As were eventually retrofitted with the gun package, but the *Six Shooter* program remains as just a footnote to the Delta Dart story. However, the new stretched-acrylic, clear-top canopy that came about at the same time as *Six Shooter* was widely retrofitted within the F-106A fleet. It is believed that the gunsight was installed in all F-106As and F-106Bs that had "vertical tape instruments," and that all such F-106As were given the capability to carry the gun. It is not known, however, how many guns were actually procured.

The "Cavaliers" of the 49th (formerly 438th) Fighter Interceptor Squadron were relatively late among Air Defense Command units to transition to the F-106A. They were stationed at Kincheloe AFB in Michigan, the base named for Capt. Iven Kincheloe, who had played an important role in developing the F-106A. (David Menard)

An F-106A of the California Air National Guard's 194th Fighter Interceptor Squadron fires an inert AIR-2 Genie air-intercept missile over the Tyndall AFB gunnery range. (U.S. Air Force)

Crew Chief Senior Airman Roy Knox shields his ears as the Delta Dart of a fellow crew chief roars into action at Castle AFB in June 1980. The "Black Panthers" of the 84th Fighter Interceptor Squadron retained the F-106 for one more year. (Author photo)

Riding out from Big Sky Country, this F-106A from the 186th Fighter Interceptor Squadron of the Montana Air National Guard was deployed to Tyndall AFB in Florida between 17 October and 2 November 1974 to take part in the William Tell gunnery competition where Air Guard units impressively took first place in three major categories that year. This aircraft returned to Tyndall 21 years later, this time as a QF-106 target drone, where an AIM-120 AMRAAM shot it down. (U.S. Air Force)

An F-102B leads a trio of F-106A "Jersey Devils" of the New Jersey Air National Guard's 119th Fighter Interceptor Squadron. Based at Atlantic City Airport, the unit operated the Delta Dart from 1972 to 1988. (Erik Simonsen)

The 171st "Six Pack" Fighter Interceptor Squadron of the Michigan Air National Guard began "packing" its "Sixes" at Selfridge AFB in December 1972. Six years later, they were phased out in favor of McDonnell F-4C Phantoms. The 171st then transferred its F-106s to the Air Force's 84th Fighter Interceptor Squadron, which kept them until 1981. This aircraft eventually became a QF-106 drone that was shot down in 1991. (David Menard)

Still on alert, the pilot's helmet rests on the cockpit sill, ready for a quick getaway. Many fighter interceptor squadrons retained the Delta Dart into the 1980s. These included the 84th Fighter Interceptor Squadron's "Black Panthers" at Castle AFB in California. (Author photo)

CHAPTER THIRTEEN

THE F-106 DELTA DART'S LONGER-THAN-EXPECTED CAREER

Crew Chief Jerry Roth designed the "Chase" logo that adorned the tails of the Delta Darts shadowing the B-1Bs during the program. It appeared in both blue and red variations. (Courtesy of Earl Blount, Rockwell International)

The 1970s were to have seen the phase-out of the Delta Dart as America's primary interceptor but, instead, the aircraft remained in this role through the decade and beyond. It would serve in significant numbers with both the Aerospace Defense Command and the Air National Guard well into the 1980s. These, however, would be its only operational assignments, other than to testing and training units within the United States.

Unlike its sibling, the F-102A, the F-106A was never assigned to overseas U.S. Air Force commands, such as USAFE and PACAF; it never saw combat in Southeast Asia; and it never was painted in either jungle or European camouflage colors. The F-106 ventured abroad only when aircraft based stateside were deployed overseas on temporary duty (TDY) assignments.

As noted previously, Delta Darts deployed overseas to Korea during the 1968 USS *Pueblo* crisis under the operational code name *College Cadence*, an Air Defense Command/Aerospace Defense Command contingency plan to send F-106 units to world trouble spots. This mission, which found Delta Darts being based at Osan AB in South Korea until May 1970, was the longest such deployment. As North Korean aircraft probed the air defenses of South Korea, the F-106s kept watch, but never saw actual combat.

Other contingency plans that never saw a weapon fired in anger included *College Key* and *College South*, both aimed at providing air defense against offensive actions launched against the United States from Cuba. The Delta Dart's "college career" also included *College Green* (involving operations over Greenland) and *College Shaft* (involving operations off the northeast coast of the United States).

As with the Delta Dagger, Convair had no foreign customers for the Delta Dart, although the company did exhibit a pair of aircraft at the Paris Air Show in 1963. Canada, Germany, and Japan expressed an interest in the Delta Dart at various times, but no serious orders were placed. Both Germany and Japan made a sizable commitment to acquiring F-4 Phantoms from McDonnell Douglas, which made a deal whereby part of the manufacturing would be done in the respective countries. Canada waited a generation to acquire the F/A-18 (as the CF-18). The Air Force had transferred some Delta Daggers from its inventory to Greece and Turkey, but it parted with no Delta Darts for foreign air forces.

In 1972, the Aerospace Defense Command began transferring F-106As and F-106Bs from its own squadrons to six Air National Guard interceptor squadrons, which functioned in an air-defense alert role. The first of these was the 186th Fighter Interceptor Squadron of the Montana Air National Guard, based at Great Falls Airport, which received its initial aircraft on 3 April. Three additional squadrons receiving Delta Darts that year were the 101st Fighter Interceptor Squadron of the Massachusetts Air National Guard at Otis AFB (Otis ANGB after 1973), the 119th "Jersey Devils" Fighter Interceptor Squadron of the New Jersey Air National Guard at Atlantic City Airport, and the 171st Fighter Interceptor Squadron of the Michigan Air National Guard at Selfridge AFB. The latter unit was nicknamed "Six Pack," a pun on the F-106A being known as "the Six."

In 1973, the Air Force had 174 Delta Darts in service, and 73 were assigned to the Air National Guard. These accounted for 73 percent of the total number of aircraft that had been produced. It is widely, but erroneously, reported that the McDonnell Douglas F-15 Eagle gradually began to replace the F-106 in U.S. Air Force units in 1972. The first operational F-15 unit, the 555th "Triple Nickel" Tactical Fighter Squadron did not achieve its initial operational capability with the F-15 until 1976, and only three tactical fighter wings were fully equipped with F-15s by 1980.

Meanwhile, the U.S. Air Force itself was undergoing reorganization during the 1970s. Much of the air defense mission of the Aerospace Defense Command was being gradually transferred to

By the 1980s, a sign of the times was the new shield that was worn on the tails of the Air Force's F-106 fleet. In 1979, all interceptor squadrons were transferred from the Aerospace Defense Command to the Tactical Air Command and fighter interceptor squadrons were eventually redesignated as tactical fighter squadrons. By the end of the decade, these tails would be painted bright orange, as the hunters became the hunted, redesignated as QF-106 target drones. (Author photo)

the Air National Guard and Air Force Reserve; on 31 March 1980, the Aerospace Defense Command was formally deactivated. Fighter interceptor squadrons that remained in the Air Force were transferred to the Tactical Air Command as tactical fighter squadrons.

More than 220 Delta Darts were in service with the Air Force and Air Guard through the early 1980s, and the Air Force did not begin a major F-106 draw-down to fewer than 100 until 1985. Having had 73 Delta Darts in 1973, the Air National Guard maintained at least 70 until 1987. More than half of the 340 total F-106s in the inventory remained in service until 1985, a quarter century after the last one rolled off the assembly line at San Diego.

The last unit operational with the F-106 as an interceptor was the 119th Fighter Interceptor Squadron of the New Jersey Air National Guard, which retired its last Delta Dart in August 1988.

As with the F-102A, the Delta Dart would have a "life after life" as a Full-Scale Aerial Target (FSAT) vehicle. Beginning in 1982, Delta Darts began going into long-term storage at the Military Aircraft Storage and Disposition Center (Aerospace Maintenance and Regeneration Center after 1985) at Davis-Monthan AFB in the Arizona desert near Tucson. Four years later, under the Pacer Six program, the Air Force awarded a contract to Flight Systems, Inc. to begin converting a total of 194 of these former interceptors parked in the boneyard into target drones under the designation QF-106A. The F-102As were converted under the PQM-102 missile designator, but the Delta Darts were redesignated with just a Q for drone prefix. Unlike the PQM-102s, the QF-106s were designed so that they could be flown either by remote control or with a human pilot aboard.

Though Flight Systems would begin the job, most of the work would eventually be done by Air Force personnel at Davis-Monthan AFB. The first Pacer Six FSAT made its debut flight in July 1987, and a small number of drones were delivered by Flight Systems before the Air Force took over.

Operational QF-106 FSAT flights began late in 1991 in the skies over the U.S. Army's White Sands Missile Range (WSMR) in New Mexico that Air Force units based at nearby Holloman AFB share with its sister service. The QF-106 drones were designed in such a way that they could take multiple hits from unarmed heat-seeking missiles before being destroyed. In this way, the Air Force was able to get good use out of its relatively pricey aerial targets. QF-106 operations finally ended after the former F-106B with tail number 57-2524 was shot down on a mission out of Holloman AFB on 20 February 1997. The last Florida-based QF-106 to go down, and the last Delta Dart drone used in a live-fire operation, was 59-0051, a former F-106B that was killed by a withering barrage that included multiple hits from 20mm cannon shells, an AIM-120 Advanced Medium-Range Air-to-Air Missile (AMRAAM), and an AIM-9 Sidewinder on 28 January 1998. By this time, the Air Force had begun expending its excess supply of F-4 Phantoms as drones.

Even before the F-106's retirement from the front lines of air defense, a small number also had a career with NASA, who had used several Delta Darts since 1961. Several years later, in 1968, two Air Force surplus F-106Bs (tail numbers 57-2507 and 57-2516) were supplied to the space agency for conversion as systems development test aircraft. Redesignated as NF-106Bs, they were registered with civilian tail numbers as N607NA and N616NA. The former aircraft was used for a variety of tasks, including the evaluation of the Weber Aircraft Zero-Zero ejection seat.

NASA's NF-106B number N816NA over the Dryden Flight Research Center at Edwards AFB in 1987. (NASA)

The F-106B that was formerly Air Force aircraft 57-2516 went on to a 23-year career as a NASA NF-106B under the civilian registrations N616NA and N816NA. Originally transferred to the space agency in 1968, the aircraft is seen here in 1980. (J. Rotramel via David Menard)

USAF INVENTORY OF DELTA DARTS DURING THE FORCE DRAWDOWN YEARS

Year	USAF Qty.	ANG Qty.	Total
1980	145	78	223
1981	142	78	220
1982	128	88	216
1983	119	92	211
1984	102	91	193
1985	64	79	143
1986	24	78	102
1987	25	70	95
1988	6	33	39
1989	6	0	6

In 1977, N607NA was reconfigured to be used in the *Global Air Sampling Project* (GASP), a mission that included the air-sampling missions flown in the immediate aftermath of the eruption of Mount St. Helens in western Washington in 1980. In these and other projects, this NF-106B conducted more than 300 flights through 1979. NF-106B N607NA, meanwhile, was also sent to the Langley Research Center at Hampton, Virginia, where it was sliced in two halves in 1984 to be used in full-scale, wind-tunnel testing.

N616NA was delivered to NASA's Lewis Research Center (now Glenn Research Center) near Cleveland, Ohio. Here, it was used to test a variety of systems, including engine nacelle design for the American Supersonic Transport (SST) program, whose research was supported by NASA. The aircraft carried an extra engine beneath its left wing to examine how the engine interacted with the high-swept wing of proposed supersonic transports. Under its right wing, it carried a comparison engine.

In January 1979, N616NA was transferred to NASA's Dryden Flight Research Center at Edwards AFB, but was soon relocated to Langley, where it would serve for a dozen years. Renumbered from N616NA to N816NA, this NF-106B was used by Langley to study the effects of intra-cloud lightning strikes on aircraft as part of the NASA Storm Hazards Program. Conducted between 1978 and 1986, the project was under the direction of Norman Crabill, assisted by project engineers Earl Dunham and Bruce Fisher, who planned the research flights and analyzed information related to improving storm hazard detection and avoidance.

The program had started in 1978 with a DeHavilland DHC-6 Twin Otter aircraft obtaining preliminary information on lightning characteristics by flying on the fringe of thunderstorms. It then continued into 1979 with N816NA flying into storms to deliberately encounter lightning strikes. NASA picked the F-106B because of "its metal-framed canopy, dual-inlet to single engine, and delta-wing configuration, which minimized the potential for lightning effects on the crew and engines, and the number of extremities that would have to be instrumented to capture important lightning data."

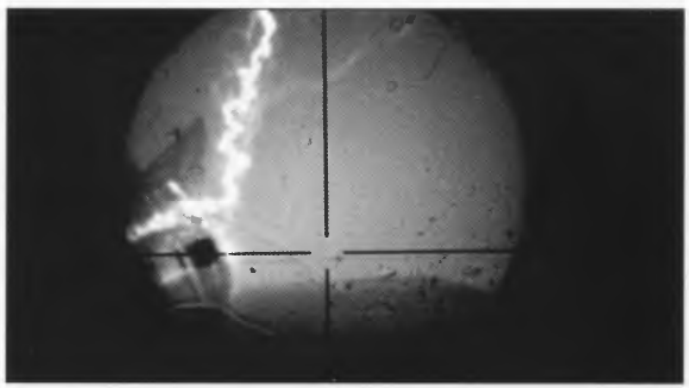
Flying over the Atlantic Ocean off Virginia and over the American Midwest at altitudes ranging from 5,000 to 50,000 feet, the NF-106B made 1,496 thunderstorm penetrations, experiencing 714 direct lightning strikes. In 1984, during one flight through a thunderstorm at 38,000 feet, N816NA was directly struck by lightning 72 times in the space of 45 minutes.

Coincidentally, back in 1959, an Air Force F-106A had taken part in the United States Weather Bureau's National Severe Storms Project, aka *Project Rough Rider,* in which a variety of aircraft based out of Florida were deliberately flown through thunderstorms to evaluate the effects of turbulence.

The Storm Hazards Program provided extremely valuable data for commercial and military operators, but the NF-106B was also used in a cooperative venture between NASA and the Air Force Weapons Laboratory at Kirtland AFB in New Mexico to compare the electromagnetic effects of lightning with those produced by nuclear blasts.

At the same time that NASA was using its NF-106B as a pincushion for lightning bolts, four F-106As and three F-106Bs were used to support the test program for the Air Force's B-1B program. During the middle 1980s, Rockwell International was in the midst of delivering its total of 100 B-1B bombers from its factory at Palmdale, California, and each aircraft required a checkout flight prior to its being delivered to the Air Force. To serve as chase planes for these Production Acceptance Flight Tests, the Air Force pulled a total of eight Delta Darts out of storage and turned them over to the

The test pilots who flew the NF-106B during the Storm Hazards Program included NASA pilots Perry Deal and Philip Brown, as well as Air Force pilots Maj. Gerald Keyser, Jr.; Maj. William Neely, Jr.; Lt. Col. Michael Phillips; and Maj. Alfred Wunschel. Brown and Deal had previously co-authored a NASA simulator study of stall and post-stall characteristics of fighter airplanes with relaxed longitudinal static stability. (NASA)



Captured by the ultra-wide-angle lens of one of its battery of cameras, a bolt of lightning races down the left side of N816NA's fuselage. After striking the nose boom, it exited at the tail before moving upward. This strike occurred at an altitude of 28,000 feet over Nag's Head, North Carolina, on 29 June 1982, during NASA's Storm Hazards Research Program. (NASA)

Beginning in October 1986, eight Delta Darts were assigned as chase planes to the Production Acceptance Flight Test portion of Rockwell International's B-1B bomber program. During this program, a fleet of four F-106As and four F-106Bs were used to shadow the bombers for four hours as each one made its initial flight. (Courtesy of Earl Blount, Rockwell International)

Seen here during a 1987 mission, this F-106A was the last of the B-1B Chase Program Delta Darts in service. Thanks to the enormously detailed website assembled by Erv Smalley and Marty Isham (www.convairf-106deltadart.com), we know a great deal about this particular bird. Produced by Convair in San Diego in March 1960, it was accepted by the Air Force on 5 April. Having spent nine months being outfitted by Hughes Aircraft in Culver City, it was delivered to the Military Air Development Center at Holloman AFB in January 1961, where it spent the next quarter century mainly as a weapons test aircraft before getting its first interceptor job with the 186th Fighter Interceptor Squadron of the Montana Air National Guard in 1986. It also served briefly with the 101st Fighter Interceptor Squadron of the Massachusetts Air National Guard before joining the B-1B Chase Program in February 1987. Retired in July 1990, it was later converted as a QF-106 target drone and shot down by a sidewinder missile on 3 September 1993. (Courtesy of Earl Blount, Rockwell International)

contractor. This program found the F-106s flying out of the same airfield where Convair had performed its own production acceptance test flights for the Air Force three decades earlier. As the B-1B program came to a close, the Delta Dart chase planes concluded their service and were returned to Davis-Monthan AFB for storage in June 1990.

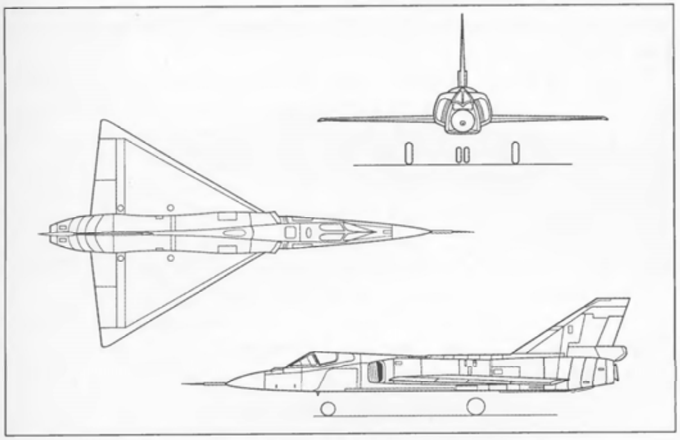
An F-106A of the Massachusetts Air National Guard intercepts a Soviet Tupolev Tu-95 Bear over the Atlantic near Nova Scotia in September 1981. (U.S. Air Force via Terry Panopalis)

After the Storm Hazards Program concluded in 1986, Delta Dart N816NA was used at Langley to evaluate an advanced aerodynamic concept known as the vortex flap, in which the leading edge of the wing was reconfigured to reduce drag and improve lift. Beginning in August 1988, 93 Vortex Flap Flight Experiment missions were flown. When N816NA made the last of these flights on 30 April 1991, NASA referred to it as the "last known piloted Convair F-106 still flying." In fact, it would not be the last. That distinction would go to the *Project Eclipse* aircraft discussed in Chapter Twenty.

Officially retired on 17 May, N816NA was transferred to the Virginia Air and Space Center in Hampton, where it would be on public display. It is one of fewer than a dozen Delta Darts—and one of only two F-106Bs—that have been retained as museum pieces. However, a number of others remain at Davis-Monthan as potentially restorable display items. Among those that survive is the first F-106A, 56-0451, which is displayed at the Selfridge AFB museum, marked with a false tail number.

For more than three full decades, the amazing Delta Dart continued on active alert. In its prime, the Delta Dart was a Soviet bomber pilot's worst nightmare, able to destroy an entire enemy bomber formation in just one shot. It was a sleek bird that was also a formidable weapon at a time when the United States really needed one.

A heat-seeking AIM-4D Falcon being uploaded into a 49th Fighter Interceptor Squadron F-106A. (U.S. Air Force via Terry Panopalis)



A three-view drawing of the F-106A. (U.S. Air Force)

A Tu-95 Bear of the Soviet Union's Long Range Aviation (Dalnaya Aviatsiya) is shadowed offshore from Cape Cod by a Massachusetts Air National Guard F-106A in April 1982. (U.S. Air Force via Terry Panopalis)

CONVAIR F-106A DELTA DART (MODEL 8) SPECIFICATIONS

Dimensions
Wingspan: 38 feet 2 inches (11.6 meters)
Length: 70 feet 9 inches (21.6 meters)
Tail height: 20 feet 3 inches (6.2 meters)
Wing area: 698 square feet (64.9 square meters)

Weights
Empty: 24,038 pounds (10,915 kilograms)
Gross: 34,510 pounds (17,670 kilograms)
Combat: 30,357 pounds (13,785 kilograms)

Powerplant
1 Pratt & Whitney J75-P-17 turbojet engine rated at 16,100 pounds (7,310 kilograms) of thrust, or 24,500 pounds (11,130 kilograms) with afterburner

Performance
Cruising speed: 594 mph (957 kph)
Top speed: 1,328 mph (2,139 kph)
Unrefueled ferry range: 1,809 miles (2,913 kilometers)
Combat range: 364 miles (586 kilometers)
Service ceiling: 52,700 feet (16,075 meters)
Combat ceiling: 51,800 feet (15,800 meters)

Armament
1 Douglas MB-1 (AIR-2A after 1962) unguided Genie nuclear rocket
4 Super Falcon guided missiles, selected in pairs from:
AIM-4E (formerly GAR-3) radar-homing guided missile
AIM-4F (formerly GAR-3A) infrared-guided missile
AIM-4G (formerly GAR-4A) infrared-guided missile

CONVAIR F-106 DELTA DART (MODEL 8) PRODUCTION CLOSE-UP

F-106A-1-CO (Model 8-24)	17
F-106A-65-CO (Model 8-24)	18
F-106A-70-CO (Model 8-24)	3
F-106A-75-CO (Model 8-24)	5
F-106A-80-CO (Model 8-24)	5
F-106A-85-CO (Model 8-24)	12
F-106A-90-CO (Model 8-24)	8
F-106A-95-CO (Model 8-24)	21
F-106A-100-CO (Model 8-24)	13
F-106A-105-CO (Model 8-24)	27
F-106A-110-CO (Model 8-24)	30
F-106A-115-CO (Model 8-24)	29
F-106A-120-CO (Model 8-24)	27
F-106A-125-CO (Model 8-24)	25
F-106A-130-CO (Model 8-24)	24
F-106A-135-CO (Model 8-24)	13
F-106B-1-CO (Model 8-27)	63
Total	340

YF-106C	1*
F-106D	Considered, but canceled
F-106X	Considered, but canceled

Selected Conversions

NF-106B (Model 8-27)	2 converted for systems development
QF-106	194 Full-Scale Aerial Targets
EXD-01	2 Eclipse Experimental Demonstrators

* Two YF-106Cs were reportedly delivered, but only one was actually delivered as a YF-106C, the other became an F-106A).

ANNUAL FLIGHT SAFETY STATISTICS

Last updated 23 March 2005

YEAR	NON-RATE	CLASS A		CLASS B		DESTROYED AIRCRAFT		FATALITIES		FLIGHT HOURS	
	Count	Count	Rate	Count	Rate	Count	Rate	Pilot	Total	Year	Cum
CY58	0	1	333.33	0	-	0	-	0	0	300	300
CY59	0	2	44.78	1	22.39	1	22.39	1	1	4,466	4,766
CY60	0	6	23.17	0	-	1	3.86	0	0	25,896	30,662
CY61	0	18	39.30	4	8.73	13	28.39	4	4	45,797	76,459
CY62	0	6	8.08	3	4.04	2	2.69	2	2	74,285	150,744
CY63	0	11	16.18	7	10.30	10	14.71	5	5	67,969	218,713
CY64	0	12	16.78	3	4.20	11	15.39	4	4	71,493	290,206
CY65	0	7	9.39	0	-	6	8.05	0	0	74,528	364,734
CY66	0	6	9.65	5	8.04	5	8.04	2	2	62,208	426,942
CY67	0	6	9.48	2	3.16	5	7.90	2	2	63,274	490,216
CY68	0	3	4.89	1	1.63	2	3.26	3	3	61,317	551,533
CY69	0	6	9.49	0	-	6	9.49	1	1	63,204	614,737
CY70	0	6	9.47	1	1.58	2	3.16	1	1	63,330	678,067
CY71	0	7	10.02	1	1.43	6	8.59	2	2	69,837	747,904
CY72	0	7	10.67	2	3.05	6	9.14	2	2	65,612	813,516
CY73	0	7	11.79	0	-	7	11.79	3	3	59,385	872,901
CY74	0	8	12.66	1	1.58	5	7.92	3	3	63,168	936,069
CY75	0	2	2.91	2	2.91	2	2.91	0	0	68,745	1,004,814
CY76	0	3	4.33	1	1.44	1	1.44	0	0	69,248	1,074,062
CY77	0	4	5.84	12	17.52	4	5.84	2	2	68,503	1,142,565
CY78	0	3	4.50	11	16.51	3	4.50	0	0	66,610	1,209,175
CY79	0	3	4.44	1	1.48	3	4.44	2	2	67,637	1,276,812
CY80	0	4	6.47	1	1.62	4	6.47	1	1	61,842	1,338,654
CY81	0	3	4.87	1	1.62	3	4.87	0	0	61,645	1,400,299
CY82	0	0	-	0	-	0	-	0	0	57,688	1,457,987
CY83	0	2	3.81	0	-	2	3.81	1	1	52,528	1,510,515
CY84	0	1	2.61	0	-	1	2.61	0	0	38,277	1,548,792
CY85	0	1	3.55	0	-	1	3.55	0	0	28,132	1,576,924
CY86	0	2	8.53	0	-	2	8.53	0	0	23,436	1,600,360
TY87	0	0	-	1	10.09	0	-	0	0	9,914	1,610,274
FY88	0	0	-	0	-	0	-	0	0	3,872	1,614,146
FY89	0	0	-	0	-	0	-	0	0	259	1,614,405
FY90	1	1	-	0	-	1	450.45	0	0	222	1,614,627
FY91	0	0	-	0	-	0	-	0	0	93	1,614,720
FY92	0	0	-	0	-	0	-	0	0	84	1,614,804
FY93	0	1	2,222.22	0	-	1	2,222.22	1	1	45	1,614,849
FY94	0	2	16,666.67	0	-	2	16,666.67	0	0	12	1,614,861
FY95	0	1	6,666.67	0	-	0	-	0	0	15	1,614,876
FY96	0	0	-	0	-	2	-	0	0	13	1,614,889
FY97	0	1	10,000.00	0	-	0	-	0	0	10	1,614,899
LIFETIME	1	153	9.47	61	3.78	120	7.43	42	42	1,614,899	1,614,899
5 Yr Avg	0	1	5,263.16	0	-	1	5,263.16	0.2	0.2	19	—

Aircraft destroyed per 100,000 flight hours 7.43080527

Chapter Fourteen

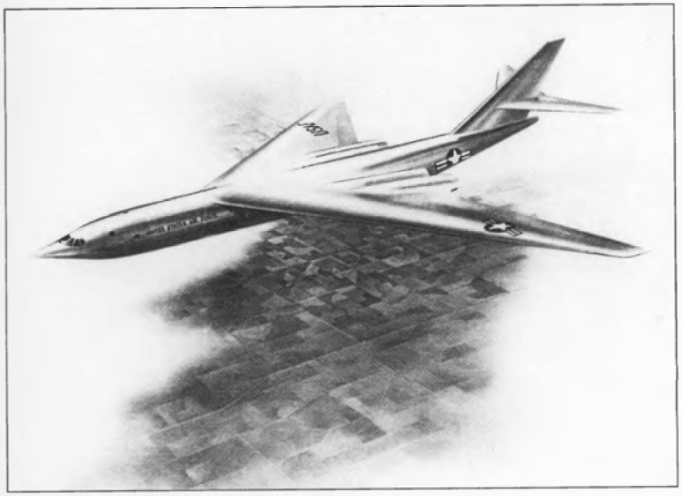
Developing the B-58 Hustler

The first XB-58 Hustler in flight. The largest of the Convair deltas was an amazing sight during its early test flights in 1956 and 1957—just as it would still be an amazing sight if it were to be seen in the skies over America's heartland today. (Convair via Author's collection)

In retrospect, it has almost become cliché to refer to the Convair B-58 as a milestone, but it truly was one of the most significant aircraft of the early days of high-performance jet aircraft. It was the world's first supersonic strategic bomber and arguably the most successful in terms of accomplishing the goals set for it. Despite this, the story of the Hustler ended with its being abruptly withdrawn from service after just one decade without a replacement that could match its performance. After it was gone, the Strategic Air Command would never again operate a strategic bomber—other than the FB-111—that was capable of sustained supersonic speed.

As we have seen, when World War II ended, the USAAF hit the ground running so far as technology was concerned. Requests for proposals sought jet interceptors, jet penetration fighters, and jet fighters to match every mission. The USAAF would also seek jet bombers. In the late 1940s, the USAAF's road map to future combat aircraft was clear. There should be jet fighters for the Tactical Air Command and the Air Defense Command, and soon there would also be jet bombers to project the might of the Strategic Air Command. Then, there would be *supersonic* jet fighters, and as soon as possible thereafter, large, long-range, supersonic bombers.

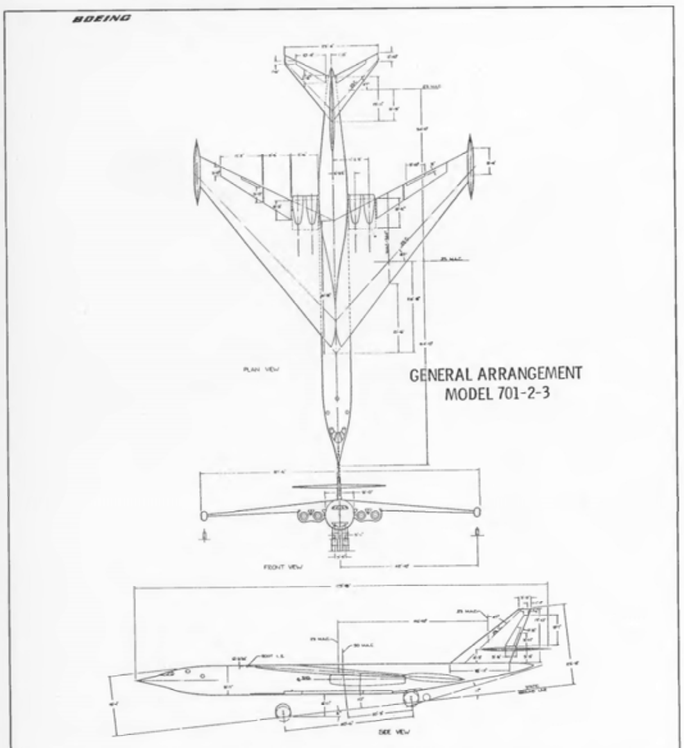
In the mid-1950s, Convair was an industry leader in high-tech strategic weapons delivery systems. There was more potential destructive power in this pair of Convair offensive weapons than in all of the B-24s built here at Fort Worth during World War II. A Convair YB-58A Hustler (tail number 55-663) equipped with an MB-1C weapons pod is seen here parked next to a Convair SM-65 (formerly B-65) Atlas ICBM. Hustlers were produced here at Convair's Fort Worth facility, while the Atlas production was centered at Kearny Mesa, on the north side of San Diego. The fourth Hustler to be built (aircraft 55-663) was involved in MB-1C drop tests during 1957, the same year that the Atlas ICBM first became operational with the Strategic Air Command. The MB-1C pod contained a W39Y1-1 nuclear weapon as well as 4,172 gallons of jet fuel. Across the runway in the background, Boeing B-52s and KC-135s are barely visible on the ramp at Carswell AFB. (Author's collection)



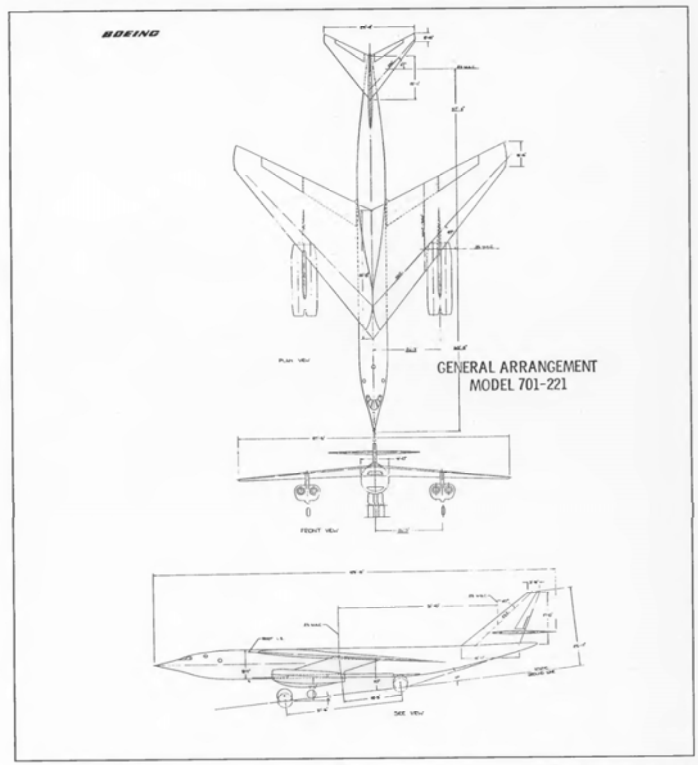
In terms of the technology that the USAAF sought, the American aircraft industry seemed poised to deliver. Having built 295,959 aircraft between July 1940 and August 1945, the American aircraft industry had produced and delivered more aircraft faster than anyone had ever done (or would *ever do* for that matter), so its production prowess was solidly established. So too was American technical expertise. Looking at its wartime achievements from the vantage point of the autumn of 1945—and against the backdrop of that guiding principle of "higher and faster"—a smug American aircraft industry simply shrugged and asked, "How high and how fast?"

The answer, coming from the aircraft buyers in that five-sided building on the Potomac, was that future combat aircraft should be jets, and supersonic jets as soon as possible after that. When World War II ended, all of America's aircraft manufacturers had military jet

This April 1951 artist's concept of the Boeing Model 701-1-1 shows an aircraft quite like the final proposal that was officially designated as the XB-59, but never built. (Author's collection)



This three-view drawing of the Boeing Model 701-2-3 (XB-59) concept is essentially like the Model 701-1-1, with wingtip pods but with less blending of the wing's trailing edge around the engines. At first glance, it looks like someone left the windows open in the P6M blueprint room at Martin! (Author's collection)



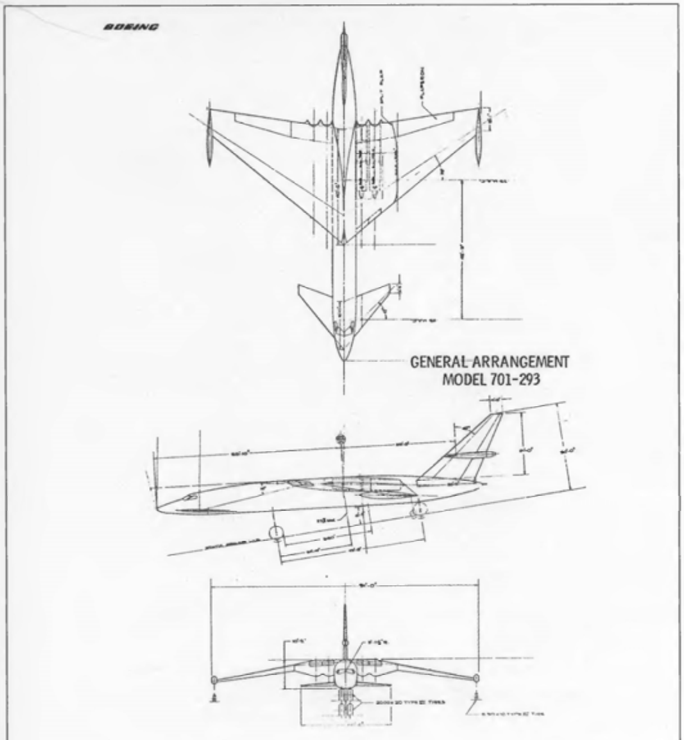
This three-view drawing of the Boeing Model 701-221 (XB-59) concept shows an aircraft similar to the Model 701-2-3, but with the engines paired into nacelles on the leading edge (as with the Boeing B-47 and B-52), rather than blended into the wing. (Author's collection)

The B-58 was a fast aircraft, but its relatively short range troubled Gen. Curtis LeMay, Commander in Chief of the Strategic Air Command. LeMay's plan for his command was for its bomber fleet to have intercontinental reach. He favored the slower, but longer range, Boeing B-52 over the B-58, but ultimately agreed that his command would acquire some of both. (U.S. Air Force)

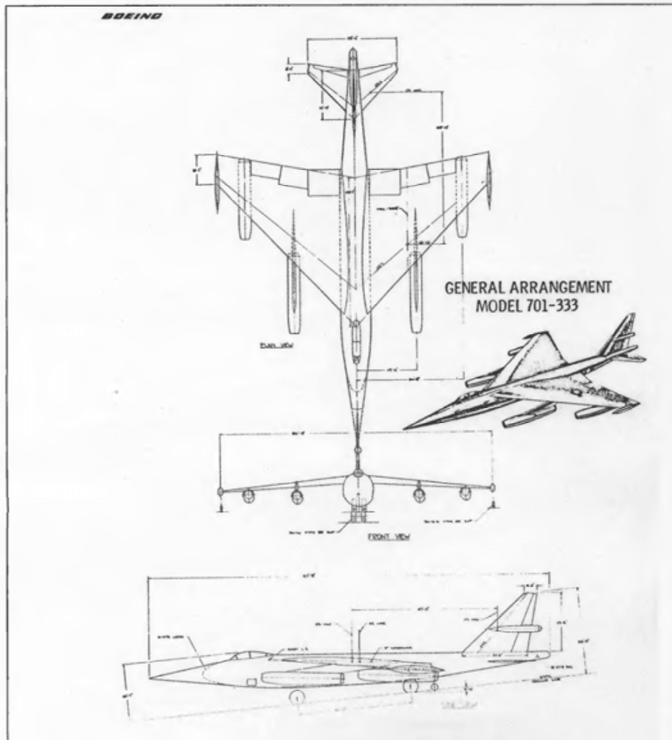
aircraft under development—with two already having been flight-tested. Though the sound barrier had yet to be conquered, engineers were already confidently working on the issues related to supersonic flight, first with research aircraft, and then with single-engine fighters and multi-engine bombers.

The first generation of subsonic jet bombers—the Douglas B-43, the North American Aviation B-45, the Consolidated Vultee B-46, the Boeing B-47, and the Martin B-48—were already in development in 1945, and all had made their first flight by the end of 1947. Originally, the bomber designers, like the fighter designers, hung jet engines on familiar, straight-winged airframes. However, analysis of German aeronautical data led to a revolution in airframe design. George Schairer at Boeing was the first to adapt a swept wing to a bomber design and Boeing's B-47 was the only swept-wing aircraft amid that first generation of jet bombers. The B-47 was also destined to be produced in larger numbers than any other American jet bomber.

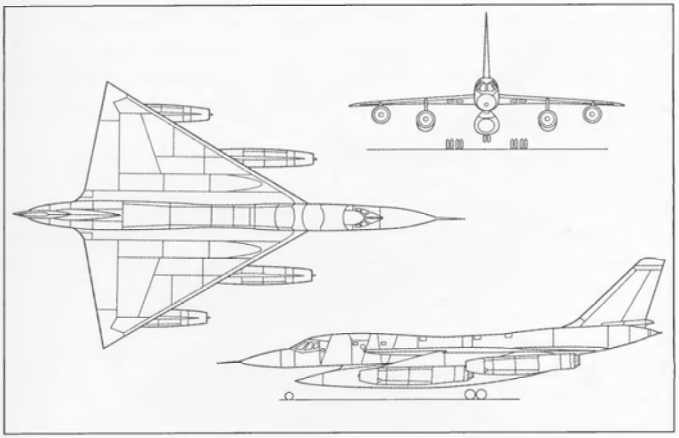
The road that would lead to America's first *supersonic* strategic bomber began in October 1946 with the USAAF's Generalized



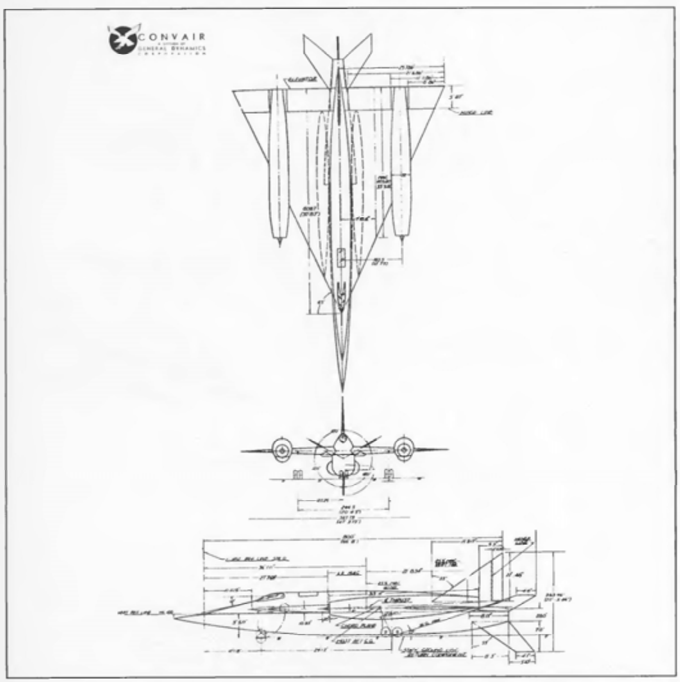
The "fifties hood ornament" look of the Boeing Model 701-293 (XB-59) concept used canards such as Convair would later use on its NX-2 nuclear-powered bomber concept, and as North American Aviation would use on its XB-70 Valkyrie, the world's largest aircraft to fly at Mach 3. (Author's collection)



The Boeing Model 701-333 (XB-59) concept was about as close as Boeing came to a delta-winged configuration. The front view and the dotted lines in the nose of the other views show that Boeing had in mind basing the fuselage of this variant on that of its B-47. (Author's collection)



This three-view drawing of the B-58A shows an airplane that was generally identical from these perspectives to the earlier XB-58 and YB-58. (U.S. Air Force)



In this three-view drawing of the early Convair proposal for Weapon System MX-1626, the streamlined weapons pod conforms to the aircraft's fuselage so that the contours of the two objects are blended to appear as a single dart-shaped object. The subsequent Model 4 concept would have two distinctly separate shapes. It would become a reality as the B-58. (Convair via Author's collection)

Bomber (GEBO) study, which, as the name implies, was more of a general exploration of the limits of bomber technology than a specific study aimed at a specific aircraft type. The GEBO studies continued as the USAAF became the independent U.S. Air Force in September 1947, and as the Soviet Union began to emerge as a serious threat to world stability with the Berlin Blockade of 1948.

Under GEBO II, which began in March 1949, the program objectives came into sharper focus, and after the detonation of the first Soviet nuclear weapon five months later, the urgency increased. In April 1950, under GEBO II, the goal was an aircraft with a combat radius of more than 3,500 miles that was capable of attacking its target at speeds up to Mach 1.5, and of providing the basis for a reconnaissance variant with like performance. Officially, the aircraft would be the "High Altitude Bomber/Reconnaissance System." An initial operating capability with the Strategic Air Command was targeted for 1958.

A beautifully lit photograph of a B-58 coming off the end of the elevated assembly line at Convair's Fort Worth factory. The assembly line was raised 9 feet off the factory floor to facilitate work under—as well as around and on top of—the aircraft. The B-58 was then hydraulically lowered for what Convair referred to as its "first gentle landing." The hydraulic lift worked on the same principle as the service-station grease rack consisting of three platforms rising from the floor. One was under the nose section, the other two were under the main gear. The main gear lifts each had a capacity of 40,000 pounds and the nose platform could carry a 20,000-pound load. Designed by Convair's plant engineering department, this lift was constructed and installed by the Joyce-Cridland Company of Dayton, Ohio. (Convair via Author's collection)

This early Fort Worth family photo shows the second XB-58 in the foreground, and the third YB-58 in the center, surrounded by three other early YB-58s. Weapons pod B-119 is visible top center. The weapons pods were very much part of the system and were produced in parallel with the host aircraft. The XB-58 wears the Air Force Flight Test Center shield on its tail. (Convair via Author's collection)

In 1957, the fifth Convair Model 4 airframe was completed with neither tail nor tail number and shipped from Fort Worth to Wright-Patterson AFB in Ohio beneath a Convair B-36F for static structural tests. For this exercise the two inboard propellers had to be removed from the B-36F, and it could not retract its landing gear. Ironically, one of the earlier pre-B-58 operational scenarios imagined for a notional Convair supersonic bomber was to carry it to the vicinity of the target beneath a B-36 and then release it to complete its mission at supersonic speeds. (Convair via Author's collection)

Just as swept wings had not necessarily been anticipated when the USAAF first sought jet bombers, nobody knew in the late 1940s what a *supersonic* jet bomber would look like. In the simplest terms, the U.S. Air Force wanted a supersonic bomber, but didn't care *how* the potential contractors arrived at that end. Most of the aircraft that reached the proposal stage, however, were dart-shaped, swept wing aircraft. Convair, of course, was working with a delta-wing design.

Convair was also considering an innovative solution to the problem of range. Jet engines still did not have the long legs that strategic planners wanted in bombers, so Convair initially studied the concept of a supersonic strike aircraft that would be carried to a point close to its target and then air-launched by its own very long range B-36 Peacemaker.

Many of the airframe makers that were working on potential supersonic bombers were also looking at designs where the payload would be carried in an aerodynamic external pod, rather than an internal bomb bay. This way, the fuselage could be streamlined for faster speed and there would be less weight on the return flight from the target.

By early 1951, only Boeing and Convair remained as serious competitors for the new supersonic bomber. Both companies were proposing aircraft with four turbojet engines, although many and various engine position configurations were explored—and wind tunnel-tested—by both contractors. A great many design studies were produced under Air Force "MX" project designations. Boeing's proposals were given the company model number 484, and generally developed under the umbrella of *Project MX-1712.* These were designed with swept wings, while Convair's *Project MX-1626* designs were, of course, delta-winged.

In December 1951, the Air Research & Development Command issued a General Operational Requirement (GOR) that detailed precisely what was needed and the two contractors went to work to finalize their proposals. Among the specifications in the GOR was that the aircraft would have to be capable of speeds above Mach 2. The aircraft would have to be not only fast, but very fast.

The two projects evolved into Boeing's Model 701, known to the Air Force as *Project MX-1965,* and Convair's Model 4, identified by the Air Force as *MX-1964.* In 1952, these two "finalists" received the official designations B-59 and B-58, respectively.

In October 1952, the Air Research & Development Command picked the Convair MX-1964/B-58 over the Boeing MX-1965/B-59 for further development. Though no firm production contract was issued or implied for Convair, Boeing was now out of the running completely. In November, Gen. Hoyt Vandenberg, the Air Force Chief of Staff, formally confirmed the Air Research & Development Command choice and by the end of the year his deputy for development had endorsed a tentative production schedule based on the four-year procurement of 244 of the aircraft.

Signed in February 1953, the initial B-58 acquisition contract called for two aircraft to be flight-ready by January 1956. It was originally planned that one would be a B-58 bomber version, and the other an RB-58 reconnaissance version, and they were given the respective weapons system contract designations WS-102A and WS-102L. Though the aircraft's original designation has been questioned, it is believed that the initial designation of the XRB-58 was subsequently changed to XB-58 and later to YB-58. After initial flight tests, it would be modified to become a TB-58 trainer.

Convair would spend all of 1953 refining the design of its Model 4, and during this process, an unpredictable, but major, design problem with supersonic aircraft had emerged. The first hint of this had come during testing of Convair's own YF-102 at the National Advisory Committee on Aeronautics (NACA) high speed wind tunnel at Langley Field in Virginia.

It was here that NACA aerodynamicist Richard Whitcomb made the discovery of shock waves forming unexpectedly on the trailing edges of the wings. Whitcomb had earlier proposed his Area Rule by which Convair engineers were able to redesign the YF-102 fuselage and transform it into a supersonic airplane. The revised Coke-bottle-shaped fuselage that was introduced in the YF-102 was also adapted at this time for the B-58's fuselage.

A full-scale mock-up of the resulting Configuration II Model 4 aircraft was unveiled in August 1953. Another important design feature of Configuration II that would be subsequently changed was the weapons pod. In most previous designs dating back to MX-1626 and before, the streamlined pod had conformed to the aircraft's fuselage.

In other words, the contours of the two objects had been blended so as to appear as a single dart-shaped object. Indeed, that which appeared to be the tip of the aircraft's nose had actually been the tip of the pod, which was longer than the fuselage.

In October 1953, after evaluating Configuration II, the Air Research & Development Command's Wright Air Development Center decided that the pod could be shortened and repositioned below the fuselage on a pylon. One aspect of the "large pod" concept seems particularly unwieldy and even dangerous. Because of the size of the pod, the nose gear had to be attached to the pod—not the fuselage—and jettisoned on take-off. Shortening and detaching the pod allowed Convair to use conventional nose gear.

Configuration II also finalized the flight deck layout. The crew of three—pilot, bombardier-navigator, and defensive systems operator (DSO)—was to be accommodated in a tandem arrangement, each with a separate compartment and a separate ejection seat. There was no provision for a copilot, except in the later TB-58A training aircraft, which had dual controls.

The Configuration II aircraft also had its four engines paired into two underwing nacelles. The reason was an assumption that maintenance would be facilitated by this arrangement. However, wind-tunnel tests indicated that the large nacelles caused an unacceptable amount of aerodynamic drag, so this layout was changed to four individual mountings in Configuration III, the mock-up of which was displayed in August 1954.

Meanwhile, as was then the case with the YF-102, engine delays were a major headache in B-58 development. The Mach 2 General Electric J79 engine specified for the B-58 was now nearing operational readiness, but it was still not available. In order to not hold up the B-58's progress, it was decided to equip the first few B-58 aircraft with the Mach 1 Pratt & Whitney J57-P-15 engines similar to those in use by Convair in the F-102 program. These early B-58s could, it was supposed, be retrofitted with the proper engines later.

Following an October 1954 inspection of a full-scale Configuration III mock-up at Convair's Fort Worth, Texas, facility, the Air Force expanded the initial order for two B-58 prototypes to add 11 B-58A service test aircraft.

Despite the green light represented by these orders, the response to the B-58 project within the U.S. Air Force was divided. The opposing points of view were represented by the enthusiasm of Maj. Gen. Clarence Irvine of the Air Materiel Command, and the skepticism of Gen. Curtis LeMay, Commander in Chief of the Strategic Air Command. Irvine favored the project because he believed that the leap in aeronautical technology inherent in the Mach 2 supersonic B-58 was worth its cost in terms of a proportion of the Air Force budget.

LeMay, who headed the command that would put the B-58 into operational use, was concerned about the B-58's range, which would be about half that of the long-range, long-endurance Boeing B-52 Stratofortress that was entering squadron service in the mid-1950s. The mission of the Strategic Air Command was to attack strategic targets deep inside the Soviet Union in the time of war, and LeMay's experience in strategic bombing during World War II told him that, with distant targets, range was a more important characteristic for a bomber than speed. LeMay questioned the notion of earmarking a sizable portion of the Air Force budget for developing and fielding a bomber with "short legs."

Short legs were not a new concern to the Strategic Air Command, but the organization had compensated for this through the acquisition of a large fleet of Boeing KC-97 aerial refueling aircraft. However, the KC-97s were piston-engined aircraft that could barely keep up with the Strategic Air Command's Boeing B-47 Stratojets. Until the KC-97s had their power augmented by the addition of jet engines, the Stratojets had to slow to near stalling speed to take on fuel. The faster B-58 was just *too* fast for the KC-97s. LeMay eventually found the bomber somewhat more palatable after the advent of the Boeing KC-135 Stratotanker, an all-jet aerial refueling aircraft.

In 1954, internal Strategic Air Command planning papers even went so far as to propose the complete elimination of the B-58, because its unit cost was significantly higher than that of the B-52. LeMay's biggest concern was that its presence in the Strategic Air Command budget might interfere with his building up the Strategic Air Command B-52 fleet.

Efforts to cancel the B-58 program entirely would continue until as late as August 1955, and the definitive contract for the first 13 aircraft (along with 31 MB-1 weapons pods) was not issued to the manufacturer until December of that year. Because of LeMay's concerns, the Air Research & Development Command downgraded the urgency of the B-58 program in 1954, emphasizing it as a potential test aircraft, rather than as a potential production aircraft.

A decision to order more than the initial 13 aircraft would be deferred until 1956. Interestingly, one of the elements in the decision to go ahead with deploying the B-58 was that it would force the Soviet Union to invest in the development of a Mach 2 interceptor to counter it.

An additional 17 Block 10 B-58As were ordered in fiscal year 1958. These would be redesignated on the assembly line and completed as RB-58As. These aircraft were intended to carry a reconnaissance pod, but most were used in test programs along with the B-58 and B-58A aircraft. Most of the RB-58As were later adapted to B-58A production standards and used in operational units. One of these RB-58As was converted to a TB-58A trainer, one aircraft was retained for static stress and fatigue testing, and three aircraft were destroyed in test program crashes between 1958 and 1960.

Nearly all of the first 30 B-58As were redesignated at least once during their service lives, and one of the early B-58s was not designated at all. Built and delivered in 1957 after the fourth B-58, it was an incomplete airframe that was given no serial number and not included in these above totals. It would be delivered, with no engines attached, to Wright-Patterson AFB, Ohio, for static testing. It was flown to Ohio bolted beneath a Convair B-36 bomber. This temporary, one-flight configuration was similar to that which had been imagined for the air-launched bomber studied nearly a decade earlier under GEBO II.

TESTING THE B-58 HUSTLER

In 1957, the first two YB-58As were sent to Kirtland AFB in New Mexico for test drops of the weapons pods at the Holloman AFB range adjacent to the U.S. Army's White Sands Missile Range. For these tests, the two-component pods (TCPs) were painted in a two-tone paint pattern for easier assessment of movie film that was shot of the drops. The first supersonic drop was made from an altitude of 40,000 feet on 30 September. (Convair via Author's collection)

The first B-58 prototype (tail number 55-0660) was completed at Fort Worth in August 1956 and formally rolled out on 4 September. By this time, a prototype of the General Electric J79 engine was also ready, so the J57 was never used as an interim powerplant. The first run-up of the installed engines took place at the beginning of October, and taxi tests began at the end of the month.

The maiden flight of the first B-58 took place on 11 November 1956, with veteran Convair test pilot Beryl Arthur Erickson at the controls. Erickson had begun his career with Consolidated Vultee delivering PBY Catalina flying boats from San Diego to the Far East. He was later the principal test pilot on the B-24 program, and in August 1946, he was the first pilot to fly Convair's six-engine B-36 intercontinental strategic bomber. He went on to log 7,000 hours in B-36s of various types, including three flights of more than 10,000 miles.

Convair systems specialist John McEachern and flight-test engineer Charles Harrison flew in the bombardier-navigator and defensive systems operator stations on the debut mission.

"Everything went smoothly," Erickson recalled in a 1992 conversation with Eric Hehs, the managing editor of Lockheed Martin's Code One *magazine. "There was no tension or confusion. We were absolutely confident when we climbed into the plane. As soon as we were latched in and the hatch was closed, we started the engines in rapid order and notified the tower that we were coming out. We had free access to the runway. We didn't have to ask for takeoff approval. We taxied north toward Lake Worth, with our F-102 chase aircraft following. We turned around, as did the chase aircraft—then told the chase aircraft to take off. Moments later, we set our engines to takeoff power and took off smoothly with the chase coming in trail position behind us."*

The engines were fully operative on the first flight, including the afterburners, but they were not used. As Erickson later observed, the weight of the aircraft without its weapons pod was so little that the afterburner was unnecessary. Continuing to fly without the weapons pod, aircraft 55-0660 went supersonic for the first and second times in two separate flights conducted on 30 December, achieving a maximum speed of Mach 1.31 at 35,000 feet.

Because of its intended high-speed capabilities, people at Convair had been referring to the B-58 unofficially as "a real hustler"

The XB-58 made its debut in 1956, rolling out of the Fort Worth factory on 4 September. Convair test pilot Beryl Arthur Erickson made the aircraft's historic first flight on 11 November 1956. (Convair via Author's collection)

for several years, and by the end of 1956, the Air Force made the name official.

During February 1957, the second B-58 "Hustler" (55-0661) joined the test program and made the program's first supersonic flight with the MB-1 weapons pod in place on 16 February. The first flight at the required operational speed of Mach 2 occurred on 29 June 1957, with aircraft 55-0660 carrying the MB-1 pod at 43,350.

Meanwhile, the first two B-58As, aircraft 55-0662 and 55-0663, had been completed and were sent to Kirtland AFB near Albuquerque in New Mexico for tests involving the dropping of the weapons pods. While the aircraft would fly from Kirtland AFB, the actual test drops were made at the Holloman AFB range adjacent to the U.S. Army's White Sands Missile Range, also in New Mexico. Aircraft 55-0662 made the first subsonic drop on 5 June 1957, followed by the first supersonic drop—from an altitude of 40,000 feet—on 30 September. The first Mach 2 release of the MB-1 was made on 20 December from 60,000 feet.

Between January 1958 and August 1960, Air Force B-58 operations were officially assigned to the 6592nd Test Squadron, which was jointly "owned and operated" by the Air Research & Development Command and the Strategic Air Command. On 1 August 1960, all B-58 operations, including Category II and III evaluations, were officially transferred to the Strategic Air Command.

Flight testing of the Hustlers, which was conducted mainly at Edwards AFB in California, also demonstrated the aircraft's ability to sustain a supersonic cruising speed in excess of 90 minutes. On 15 October 1959, a B-58A (58-1015) flew from Seattle, Washington, to Carswell AFB, Texas, in 70 minutes at an average speed of nearly 1,320 mph in the Hustler's first sustained Mach 2 flight.

The vitally important issue of inflight refueling was addressed in a series of trials with KC-135s that was begun in June 1958. The Hustler proved itself to be especially suitable for these operations, which would enhance its mission capability by lengthening its legs.

However, despite the successes in achieving the desired performance levels, flight tests also pointed out serious problems with the first-generation J79-GE-1 engines. Uneven fuel management that caused more fuel to remain in a tank on one side of an aircraft longer than on the other caused the weight of the aircraft to be asymmetrical. This resulted in problems of balance and stability that were magnified when the aircraft is flying at Mach 1 or above. Not only was this a potential immediate danger for the crews, it was seen to be resulting in fatigue cracks in the aircraft. Many of these problems were ironed out with the retrofit of the J79-GE-5 engines, which were first delivered to the factory in September 1957.

All but the first seven Hustlers were flown with General Electric J79-GE-5A or -5B engines, which, at sea level, were rated at 9,700 pounds of continuous thrust, with a maximum thrust rating of 15,600 pounds. This compared to 8,900 and 14,500 pounds, respectively, for the original J79-GE-1.

The fourteenth Hustler, and the first B-58A production aircraft (59-2428), was delivered to the Air Force early in 1959. Unfortunately, the program was running behind schedule and a number of bugs had yet to be wrung out of the flight test aircraft, as well as from the AN/ASQ-41 bombing and navigation system and the AN/ALQ-16 electronics countermeasures system.

Meanwhile, there would be three fatal in-flight accidents between December 1958 and November 1959 that were attributed to control problems, as well as one fatal accident on take-off from Fort Worth.

Film crews document the first XB-58 around the time of the debut flight in November 1956. (Convair via Author's collection)

The first XB-58 on the ramp, circa late 1956, with hatch doors open. (Convair via Author's collection)

A fifth Hustler was lost in a fire at the factory during this period, and another two fatal in-flight losses would occur during the first half of 1960. The high rate of accidents and crashes in 1959 and 1960 was such that the Strategic Air Command would postpone taking the program over from the Air Research & Development Command—and they restricted the fleet to subsonic flight for nearly a year while control system problems were addressed.

The crew losses pointed out that the Convair ejection seats were not adequate to permit a crewman to safely escape at supersonic speeds. This led to the B-58A being redesigned with an "escape capsule" system. Developed by the Stanley Aviation Corporation in Denver, Colorado, the capsules had airtight clamshell doors and independent pressurization and oxygen supply systems. In this way, the crew could use the capsules as survival aids in case of cabin depressurization. The pilot's capsule operated in such a way that he could continue to fly the aircraft when it was closed. When the crew did punch out, the capsules were jettisoned up and away from the aircraft by a rocket motor and then dropped to earth via parachute. In the event of a water landing, flotation cells could be manually inflated, turning the capsules into life rafts. Beginning in 1962, these capsules replaced the ejection seats.

As the B-58A flight-test program evolved, there were also maintenance issues, and costs were exceeding estimates. Against this backdrop, Air Force headquarters ordered the Strategic Air Command to scale back its planned deployment.

On 11 June 1959, with Gen. Curtis LeMay now serving as Air Force Vice Chief of Staff at the Pentagon, the Air Force announced plans to purchase 290 B-58s. Including the 30 pre-production and test aircraft, this number would have allowed for five operational Strategic Air Command bomb wings. However, because of the losses, delays, and cost overruns, this acquisition order was cut nearly in half in December 1959. Gen. Thomas Power, who had succeeded Gen. LeMay as Commander in Chief of the Strategic Air Command (CINC/SAC) in July 1957, reduced the total number of B-58s from 290 to just 148. This total would be slashed again, and ultimately, only 116 Hustlers would be built.

Flight testing of the B-58A aircraft officially concluded in April 1959, although production flight testing would continue until the delivery of the last three of 116 B-58 aircraft on 25 and 26 October 1962. Coincidentally, this would occur during the Cuban Missile Crisis.

In February 1960, as the long-awaited and often-delayed moment of the B-58's initial operating capability finally neared, the Air Force undertook the *Junior Flash-Up* project, which was aimed at converting low-time pre-production and flight-test aircraft to operational status by upgrading their avionics and retrofitting aircraft. These included eight B-58As that were converted as operational dual control TB-58A trainers, the first of which was delivered in May 1960.

A batch of 17 Block 10 B-58As later became RB-58A aircraft, and the first B-58A (55-0662) was briefly redesignated as NB-58A when used to test the J93-GE-3 turbojet that was designed to be used in the North American Aviation B-70 Valkyrie and F-108 Rapier programs. The J93-GE-3 had twice the thrust of the Hustler's J79-GE-5, and the huge B-70 was to have been the supersonic successor to the B-52, the B-58's "big brother." Only two XB-70s were built, and no production series B-70As were ordered, while the XF-108 was canceled without reaching the prototype stage.

An additional *Flash-Up* project undertaken in 1960 was *Senior Flash-Up*, which was an effort to standardize the existing B-58 fleet. Reminiscent of the F-106 program, after four years of testing, modification, and retrofitting, it could be said that no two of the Hustlers were alike, and this presented a maintenance and operational nightmare. *Senior Flash-Up* was intended to correct this situation by introducing a measure of commonality so that the existing Hustlers could become useful members of the Strategic Air Command force. At the same time, upgraded Tactical Air Navigation (TACAN) systems were added. The first *Senior Flash-Up* B-58 was delivered on 7 November 1960.

THE TRAINER WAS AN AFTERTHOUGHT

As noted, the TB-58A trainer conversions followed after the initial deployment of the Hustler as a bomber. When the aircraft was being developed, the requirement for a dedicated trainer variant had apparently not been apparent, but as it inched toward its operational debut, this need became unmistakable. The Hustler had no provision for a copilot, and the pilot was physically isolated from the other crewmembers. There was an access tunnel between the middle and aft crew positions, but there was none between the pilot's compartment and the middle crew compartment that was meant to be used in flight, and especially with the crew wearing flight gear. In practice, the tunnel between the two aft positions was so narrow and cramped that it was almost never used in any of the Hustler variants.

This need for a Hustler crew trainer was solved by completely revamping the middle crew station of seven B-58As and the second B-58, and installing a second set of flight controls for the instructor pilot. These aircraft were redesignated as TB-58As. A ninth was to have been converted, but it was lost in an accident before being retrofitted. The eight were all assigned to the 43rd and 305th Combat Crew Training Schools, which were co-located with the bomb wings of the same numbers—rather than to dedicated training squadrons.

In the TB-58A conversion, the middle pilot position was offset slightly to allow some forward visibility. The aft compartment was not usually used during TB-58A missions, although, theoretically, a third set of controls might have been installed, and a second student pilot could have been accommodated here.

Originally, the first XB-58 was finished in subdued livery, but later repainted with high-visibility red trim. (Convair via Author's collection)

The first XB-58 rotates from the Fort Worth runway during one of its later test flights. (Convair via Author's collection)

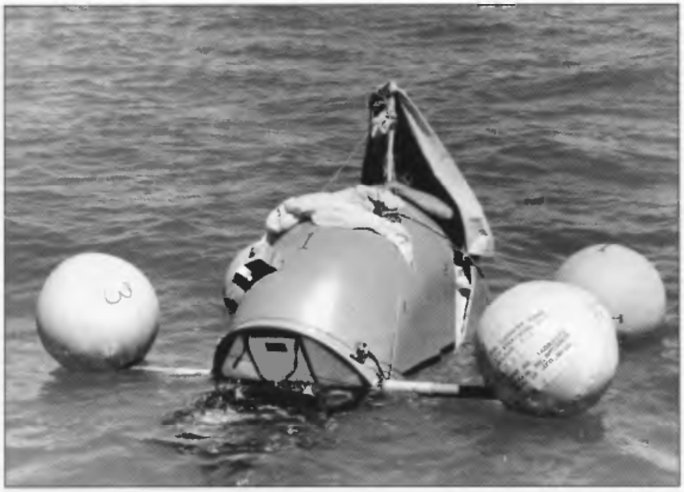
The first XB-58 during a high-altitude test flight with a bright-red MB-1 pod attached. (Convair via Author's collection)

Gen. LeMay's concern for the short range of the Hustler was somewhat assuaged when the YB-58s began to successfully rendezvous with a Boeing KC-135 for refueling compatibility tests in 1958. This aircraft, the third YB-58, was lost on 7 November 1959 when it disintegrated during a Mach 2 test flight. (Author's collection)

KC-135 boom operator's view of a YB-58 during 1958 refueling tests high over Texas. (Convair via Author's collection)

Painted in slightly different livery than its predecessor, the second XB-58 entered flight test in February 1957, and made the first supersonic flight with the MB-1 weapons pod attached on 16 February, less than three months after the aircraft's first flight. This is in marked contrast to today's latest military aircraft test programs where, literally, years can transpire before a new aircraft makes its first supersonic flight. (Convair via Author's collection)

"Yogi," a 200-pound black bear ejects from an XB-58 at Edwards AFB during tests of the Stanley Escape Capsule. Both the bear and chimpanzees were used during these tests to simulate a human pilot's physical mass and survivability without endangering human pilots before validating the capsule's performance, much like the chimps used in Project Mercury. (Convair via Author's collection)



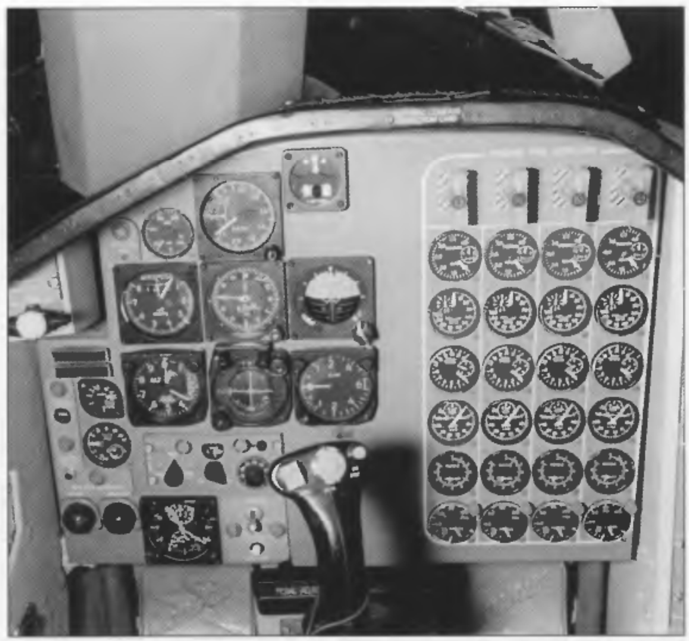
Developed by the Stanley Aviation Company of Denver, Colorado, in cooperation with Convair, the B-58 escape capsule was buoyant itself, and had supplementary flotation bag cells that could be inflated manually. The pilot floated within this high-tech "life raft," breathing through a snorkel tube. (Convair via Author's collection)

This view of the B-58 production line at Fort Worth shows the area where the unfinished fuselage was mated with the wings. Another set of wings can be seen coming together in the background. (Convair via Author's collection)

Released on 13 April 1960, this was the first photo ever seen by the public of the B-58 Hustler production line at Convair's Fort Worth plant. As described at the time, the aircraft are "surrounded by mobile work platforms moving down the line (toward the camera) on rails about 8 feet above the floor of the 4,000-foot-long factory building. At the end of the assembly line, hydraulic jacks raise built-in platforms out of the floor, making contact with the aircraft's landing gear, then lowering the bomber." (Convair via Author's collection)

After being used in electronic countermeasures testing, this YB-58 was retrofitted as an operational RB-58A. Nicknamed "Reddy Kilowatt" (after the popular General Electric logo cartoon character), it was assigned to the 43rd Bomb Wing. (U.S. Air Force)

A look into the front cockpit of the TB-58A reveals the same interior configuration as that of the operational B-58A. The center cockpit, normally occupied by the aircraft's navigator-bombardier, has dual controls for the instructor pilot in the trainer version. (Convair via Author's Collection)



The instructor pilot used the center cockpit of the TB-58A, although forward visibility was very limited. Note the stylized delta-wing airplane on the "Convair" foot pedals. (Convair via Author's collection)

The view looking forward into the center crew compartment from the aft crew station. It was probably wishful thinking to call this narrow passage a "crawlway." (Convair via Author's collection)

This excellent side view of a TB-58 Hustler shows the placement of the additional side windows that were cut into the fuselage adjacent to the middle crew compartment in order to give the instructor pilot better visibility. (U.S. Air Force)

Chapter Sixteen

Arming the B-58 Hustler

This August 1960 photograph from the test program provides a good view of the TCP as installed on the aircraft. The lower portion contained only fuel and could be jettisoned when empty. The upper portion contained a thermonuclear weapon. (Convair via Author's collection)

The weapons pod was an integral part of the overall B-58 system from the beginning. The Hustler was designed, quite simply, for no other purpose than to carry a single nuclear weapon to a single high-priority target.

Unlike the conventional and nuclear-capable bombers that had preceded it in the Strategic Air Command fleet, and those that would follow it, the B-58 was the first strategic bomber designed only to drop just a single weapon—the jettisonable MB-1 weapons pod. Of course, the kilotonnage present in that single weapon was vastly greater than any bomb bay full of conventional bombs.

The operational MB-1C pod contained a W39Y1-1 nuclear weapon as well as 4,172 gallons of jet fuel in tanks placed at both ends of the pod for balance. In a strike mission, the bomber would draw fuel from this tank en route to the target so that the whole unit could be dropped. This would leave the B-58 much lighter and capable of a fast exit from the target area.

The MB-1C had a design weight of 2,500 pounds, with the W39Y1-1 weighing an additional 6,050 pounds and the fuel tank having a maximum capacity of 27,537 pounds. The pod was 57 feet long, or nearly 60 percent of the length of the aircraft itself. Because it was about five feet in diameter, the B-58's landing gear had to be especially long in order to allow sufficient clearance. This was a particularly daunting engineering task, which Convair engineers accomplished quite successfully.

While the B-58 was deployed with the unguided MB-1C weapons pod, it was actually the second choice of a weapons system. Until quite late in the development process, it was intended that its primary offensive weapon would be a guided missile rather than the free-fall pod that was actually deployed. Often referred to in the literature as a pod,. the MA-1C missile was the same size as the MB-1C and slightly lighter at 27,108 pounds. It was to have been powered by one Ball Aerospace LR81-BA-1 rocket, which delivered 15,000 pounds of thrust for 65 seconds of flight time. It was to have been directed over its 160-mile range by a Sperry guidance system.

Because the idea of standoff weapons made sense theoretically, a number of air-launched ballistic missile (ALBM) concepts were developed during the 1950s and the MA-1C was one of these. However, because of the problem of guidance-system accuracy, it was not until the 1980s that microprocessors made ALBMs and other cruise missiles practical.

Though the powered and guided MA-1C was canceled in favor of the free-fall MB-1C in May 1957, other ALBM scenarios would remain under study for as long as the Hustler remained in service. In 1958, as the MB-1C weapons pods were in production, Convair began development of the two-component pod, best known by its acronym, TCP. The 37,970-pound-gross-weight pod was designed in two sections so that the fuel tank component could be dropped before the weapon. This would leave just the lighter weapons component, which contained sensors as well as the weapon. Offensive action was coordinated through the Sperry AN/ASQ-42 bombing and navigation system. The TCP was designed to fit the same bracketing system as the MB-1C, although the pair of components was shorter and heavier than the previous pod.

The TCP's lower fuel tank component was 54 feet in length and 5 feet in diameter. It weighed 1,900 pounds and accommodated 24,100 pounds of fuel. The upper section—officially designated BLU2/B-1—also carried some fuel along with a BA53-Y1 (Mk.53) nuclear weapon. This component weighed 11,970 pounds fully fueled and 7,700 pounds with just the weapon. Designed to conform to the convex surface of the lower pod, the BLU2/B-1 was 35 feet in length and 3.5 feet in diameter.

The first supersonic drop of the lower section occurred in May 1960 and of the upper (with an inert weapon, of course) in December 1960. Because of fuel-leak problems that were showing up in the MB-1Cs, the operational equipping of the B-58 force with TCPs began soon after the test drops.

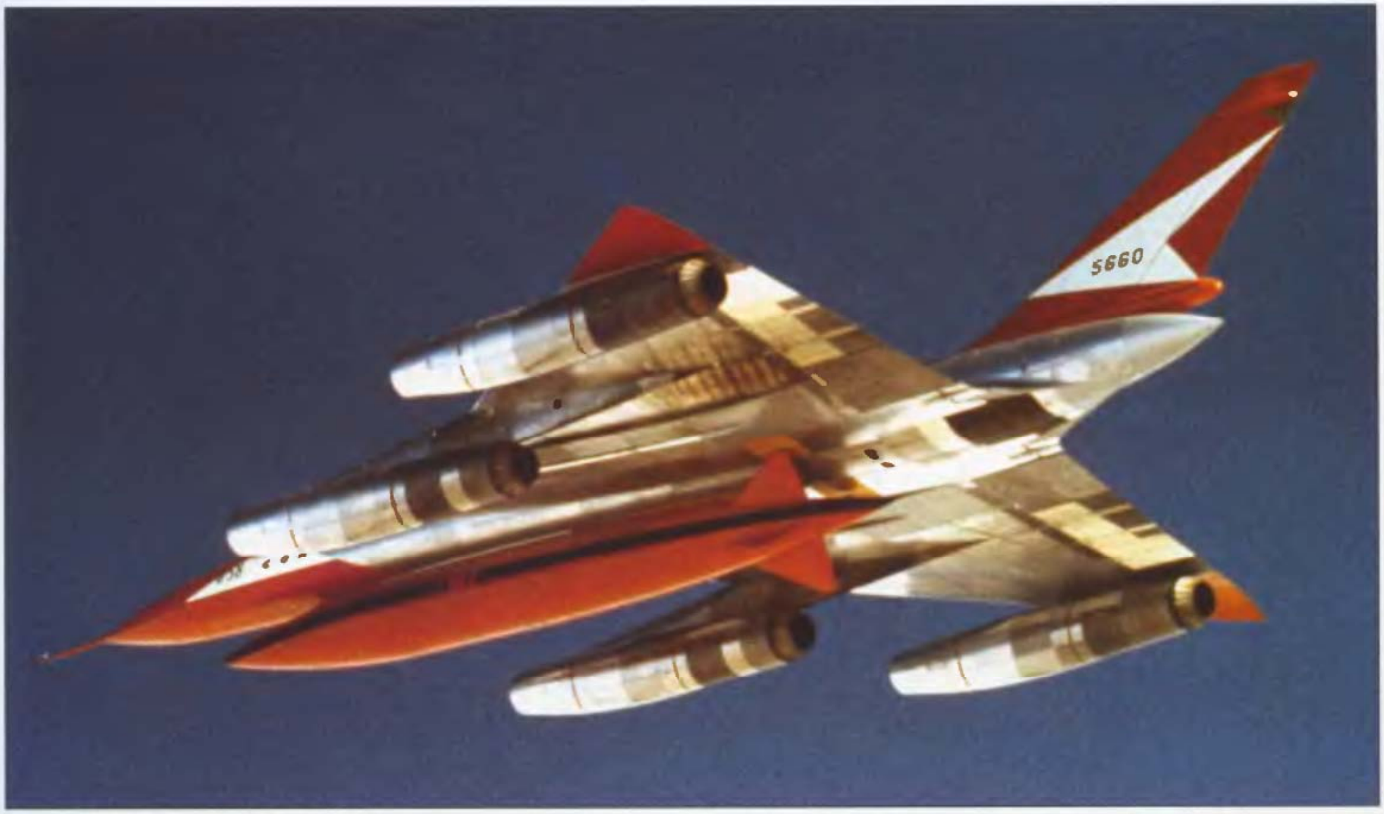
During the B-58's development, there was never any serious consideration given to its having a conventional bombing capability, but in 1959, Convair made such a proposal during an effort to sell a version of the Hustler to the Royal Australian Air Force (RAAF). The Australian proposal never went anywhere, but in the late 1960s, the U.S. Air Force studied—and even tested—using the Hustler to carry "iron" bombs on hard points beneath the fuselage.

Though the MA-1C guided missile system was canceled in 1957, the idea of the B-58 as an ALBM carrier did not go away. Air-launched strategic missiles had interested Strategic Air Command planners since the early 1950s, and, by 1960, two missile systems were being earmarked for deployment aboard the B-52 fleet. These included the jet-propelled North American Aviation Hound Dog, which was flight-tested in 1959, and the longer-range, rocket-propelled Douglas GAM-87 Skybolt, which was first test-launched from a B-52 in 1961.

The Skybolt had an interesting story of its own. It had evolved at a time when the U.S. Air Force was looking into a variety of basing systems for long-range ballistic missiles. Eventually, silo-based Intercontinental Ballistic Missiles (ICBM) would be chosen as the best option, but in the meantime, the state of the art was ground-launched Intermediate-Range Ballistic Missiles (IRBM), such as the Douglas SM-75 (later PGM-17) Thor. The Air Force wanted longer legs for its ballistic missiles and one way to do this was to air launch them. The Skybolt was deemed to be the best choice and Douglas received the contract in May 1959.

Meanwhile, the British and Australians were trying to develop a ground-launched Medium-Range Ballistic Missile (MRBM) called Blue Streak, but were running into technical problems. The Eisenhower Administration offered the Skybolt as an alternative and Blue Streak was canceled. In 1962, however, the Kennedy Administration pulled the plug on Skybolt in favor of ICBMs. This left the British and Australians, who never developed ICBMs, without a ballistic missile alternative.

At the same time that the B-58 was working its way toward the start of its operational career, Convair was developing the Atlas intercontinental ballistic missile for the Strategic Air Command. However, the B-58/ALBM projects were undertaken in cooperation with other aerospace companies, especially Lockheed, and not with Convair missiles. Among the systems that Lockheed brought to the table were



Underside of an XB-58 carrying a test version of the four-finned MB-1 weapons pod. (Convair via Author's collection)

Record-setting B-58A Firefly with an MB-1 weapons pod in operational markings. The MB-1 is easily distinguished from the later Two-Component Pod (TCP) by its four fins. (Convair via Author's collection)

variations on its X-17 experimental vehicle and its Polaris, a compact submarine-launched missile that was being developed for the Navy's first generation of ballistic missile submarines.

The X-17 was chosen as the basis for the B-58/ALBM test weapon, and the Air Force conducted four test firings from a B-58A between September 1958 and September 1959 under *Project Snap Shot*. The fourth and last of these missions involved a camera-equipped missile intended to photograph a NASA Explorer satellite.

Other ALBM projects that were never developed into actual hardware included *Project Hook Shot*, an anti-ballistic missile (ABM) concept, and *Project Close Shot*, which envisioned using a missile launched from a B-58 at Mach 2 to place an object into space. The latter was a precursor to the Pegasus system of three decades later.

The notion that the single pod carried by the Hustler could and should be a powered missile of some sort would remain alive and well for the life of the aircraft. Many systems were considered and some were tested, but the free-fall MB-1C pod remained as the standard operational weapon.

Among the offensive avionics that supported the delivery of the MB-1C operationally, the Sperry AN/ASQ-42 bombing and navigation

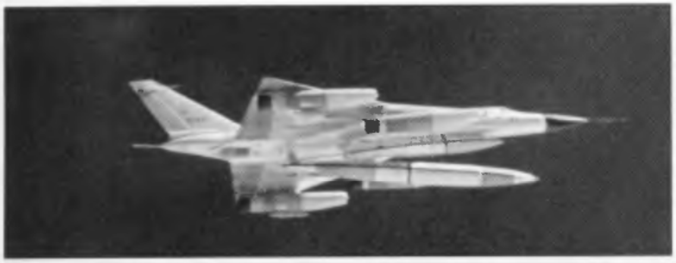
system was the most important. It was designed to accomplish the typical tasks of such a system—with the added variable of supersonic speed and what that velocity would mean to the trajectory of the unpowered weapons pod when it was released at speeds up to Mach 2.

As almost invariably happens with complex weapons systems, new needs and possibilities present themselves after deployment.

Though Convair and the Air Research & Development Command had looked at various types of pods, neither seriously considered an offensive weapon other than what could be carried in that single pod. However, almost as soon as the first squadrons became operational, the Strategic Air Command began to consider operational requirements demanding additional flexibility that were not possible with the original "single weapon/single target" scenario.

With this in mind, between 1961 and 1963, the B-58 fleet was retrofitted to allow each aircraft to carry four Mk.43 or Mk.61 nuclear bombs outside the pod on under-fuselage hard points near the wing roots.

Seen in this May 1961 photograph is a TCP separated into its two components. The smaller component containing the weapon is still attached to the B-58A Shackbuster. The concave cavity in the lower fuel pod shows how the larger component fits around the weapons pod. Assigned to the 43rd Bomb Wing, Shackbuster participated in numerous pod drop tests. (Convair via Author's collection)



Released on 1 May 1961, this was the first photo of a B-58 pod drop ever seen by the public. Having flown out of Kirtland AFB, Shackbuster is shown jettisoning the fuel tank portion of its TCP over White Sands while in supersonic flight. Note that streamlined spar at the aft end remains attached to aircraft until the fuel pod has assumed a nose down attitude. (U.S. Air Force)

Having dropped its external fuel tank, Shackbuster could then hustle toward its target at speeds of well over 1,300 mph, and at an altitude of more than 60,000 feet, carrying the weapons pod portion of its TCP. (U.S. Air Force)

In 1961, the B-58A was evaluated with a weapons load that included Mk.43 thermonuclear weapons on wing-root pylons in addition to its TCP. Conducted at Carswell AFB, these tests showed that such bombs could be carried and dropped with little difficulty at supersonic speeds. This encouraged Convair to later propose that the Hustler be equipped with conventional high explosive ordnance carried in a similar fashion. Both the U.S. Air Force and the Australian Air Force considered such a configuration, but the Hustler was probably never operationally deployed with conventional bombs. (Convair via Author's collection)

The B-58 was also used to test fire the Hughes AIM-47 (originally GAR-9), a later member of the Falcon family of air-to-air missiles, although the weapon was never intended for operational deployment aboard the Hustler. As noted earlier, beginning in 1955, the U.S. Air Force was working toward the development of an interceptor capable of speeds exceeding Mach 2, under the Long-Range Interceptor, Experimental (LRIX) program. An existing Mach 2 aircraft was needed to test the weapons system intended for such an interceptor, and the B-58 was that aircraft.

One Hustler, a B-58A (55-0665), remained with the Air Research & Development Command/Air Force Systems Command when the rest of the program was officially turned over to the Strategic Air Command. It was used in testing systems intended for use in the operational fleet, as well as systems intended for other supersonic aircraft programs. The latter included the AN/ASG-18 fire-control radar and AIM-47 air-to-air missile, as well as other systems intended for use in the North American Aviation XF-108 and later used in the Lockheed YF-12A. This B-58A aircraft was abandoned and its engines removed on the Edwards AFB range, where it still remains today, resting derelict in a sea of sagebrush.

With its offensive pod-carrying capability, the B-58 was also considered for a variety of pod systems other than those with which it was actually deployed. In the early stages of the program, it was planned that the RB-58A aircraft would carry a specifically designed reconnaissance pod. Fairchild Camera & Instrument was asked to develop the MC-1 reconnaissance pod, whose outside shell would have the same dimensions as the MB-1C pod. Inside, the MC-1 would have carried 13 cameras weighing a total of 998 pounds.

As the MC-1 was being developed, there was a parallel effort, at Convair's suggestion, to develop an MD-1 electronic warfare pod. A single MD-1 was built, but it was never flight-tested.

The MC-1 project itself was canceled in 1955 at a time when the Air Force had temporarily decided against an RB-58A variant. When the RB-58A concept was later revived, some MB-1 pods were, in fact, retrofitted with cameras and/or sensors for low-level recon operations.

The first serious revival of the RB-58A concept emerged early in 1956, when the Air Force contracted with Hughes Aircraft to develop a Side-Looking Airborne Radar (SLAR) system that would be compatible with the B-58A and its external pod attachments.

It should be remembered that, while aircraft technology made great strides during the 1950s, radar technology was still relatively primitive during this period. One measure of this was in the area of miniaturization. In contrast to optical systems involving cameras, the Hughes AN/APQ-69 SLAR system was enormous, with an antenna section alone that was nearly 50 feet in length. This meant that it required virtually the entire internal volume of the pod, which in turn meant that there was no room for fuel, and the range of the AN/APQ-69-equipped RB-58A would be less than an RB-58A with an optical MC-1 system. The unwieldy shape of the huge SLAR was such that its aerodynamic drag prevented the Hustler from carrying it above subsonic speeds.

The MA-1 ALBM was considered as a key weapon for the Convair supersonic bomber even back when it was still a developing concept and not yet wearing the "B-58" designation. However, delays and technical problems shunted it to the side and out of the picture before there were operational B-58s in service. Other air-launched missiles were later considered, but none was ever accepted for operational use with the Hustler. (Convair via Author's collection)

This Hustler actually conducted missile launches, albeit testing missiles for other aircraft types. One of the YB-58s became an RB-58, the aircraft was assigned to the Air Research & Development Command, whose shield it wears on its nose. It was used in the test program for the Hughes AIM-47 Falcon air-to-air missile that was intended for the F-108 and F-12 Mach 3 interceptors. (U.S. Air Force)

The first of two-dozen AN/APQ-69 flight-tests was conducted in late December 1959, about 10 months after Hughes delivered the first system. While the 50-mile range and 10-foot resolution of the AN/APQ-69 was impressive for 1959, the overall bulkiness of the system led to the system's cancelation in favor of a derivative of the Goodyear AN/APS-73 X-band synthetic-aperture radar.

Work on this system was begun in June 1958 at the Wright Air Development Center under the project name Quick Check. The AN/APS-73 proved to have a half-again-greater range than the Hughes system, although its resolution was poorer at longer range. The module was, however, small enough to allow the use of a modified MB-1 pod and it did allow room within the MB-1 for a modest fuel tank.

The ninth Hustler delivered (62-0668), a B-58A that was originally and coincidentally ordered as an RB-58A, may have been used to test both the Hughes SLAR and the Quick Check system. After the former project was terminated, the aircraft was re-modified for the latter and handed over to the *Quick Check* project in May 1961.

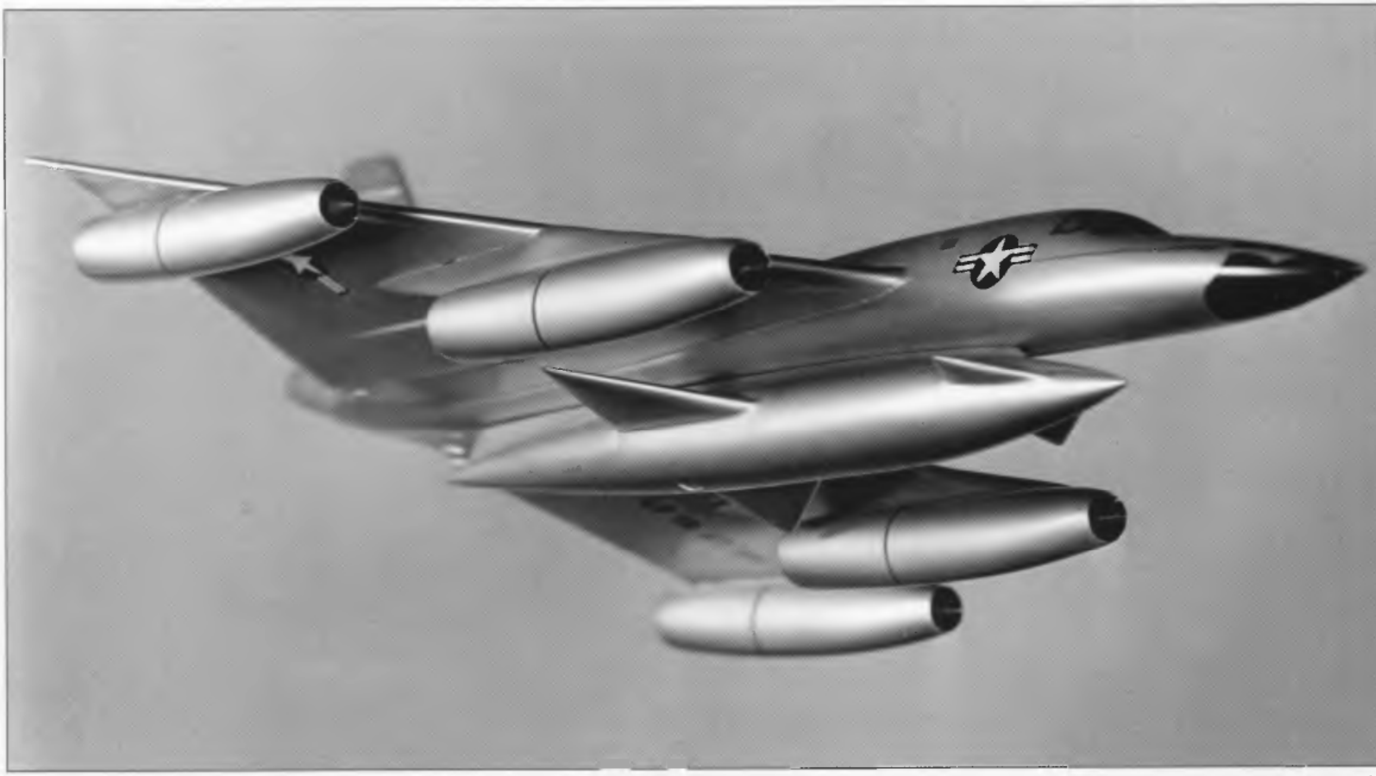
The conventional wisdom is that no other aircraft ever carried the *Quick Check* pod, and that the system was not used operationally after the conclusion of the test program. However, it was used operationally at least once during the flight-test program. The Cuban Missile Crisis, which occurred in October 1962, brought 62-0668 into action on an emergency basis when there was an urgent need for reconnaissance operations over Cuba. Both the Air Force and the Navy used their best assets. It is ironic that the only Hustler known to have ever flown an operational mission in hostile airspace was a reconnaissance test aircraft.

Defensively, the B-58 was armed with a single tail-mounted cannon. During World War II, the theory of defensive armament for bombers followed the idea that the more gun turrets the better. However, with the advent of jet bombers, it was believed that speed

THE HUSTLER PASSENGER POD

Certainly the most unusual Hustler pod concept developed by Convair was a passenger pod that would have accommodated up to five people. This proposal was suggested as a means for quickly delivering important government or military personnel anywhere in the world, though hardly economically. The concept also was seen as a possible test environment for the development of a commercial scale supersonic transport (SST). Every major airframe maker in the United States was studying the SST concept during the 1960s, and Convair developed a study concept for its Model 58 52-passenger supersonic jetliner, based on the B-58.

In addition to carrying the various weapons pods, the belly of the Hustler also served to carry the flight-test article of General Electric's massive J93-GE-3 turbojet that was designed to be used in the North American Aviation XB-70 and XF-108 programs. With the J93-GE-3 running, the Hustler's four J79s could be throttled back. Although the J93 could power the XB-70 to speeds of Mach 3, the B-58 testbed could never have flown that fast due to airframe limitations. (Convair via Author's collection)



This 1957 model photograph shows a B-58 carrying the MA-1 Air-Launched Ballistic Missile (ALBM) pod. Unlike the weapons pods, which were dropped, the missile was powered by its own rocket engine and could have been used as a standoff weapon much like the Air-Launched Cruise Missile (ALCM) that came along a quarter century later. (U.S. Air Force)

was in itself a defensive weapon, and that turrets should be located only in the tail, where they would be useful in defending against an interceptor aircraft chasing the bomber.

Because of the Hustler's speed, it was considered unlikely that an interceptor could attack from any direction other than straight on from the front or the tail. In the former scenario, because of the tremendous speeds of aircraft approaching one another at Mach 1 or faster, an interceptor pilot would have so little time to line up a shot that it could be considered virtually impossible.

Originally, a twin-barreled T-182 gun was among those considered, but by 1954, Convair and the Air Force had settled on the General Electric 20mm T-171E (M61) six-barreled rotary "Gatling gun" cannon, with fire control directed by an Emerson MD-7 radar unit. While the gun had an impressive rate of fire of 4,000 rounds-per-minute, only 1,200 rounds could be accommodated. The cannon was operated by a defensive systems operator (DSO) facing forward and sitting in the forward part of the aircraft aft of the bombardier-navigator and the pilot.

The fire-control system could be operated by automatic target acquisition (ATA) or manual target acquisition (MTA). In the former, the system automatically searched a set pattern, acquired and tracked a target, displaying the target on the radarscope and indicating to the DSO when to fire the gun. In manual operation, the DSO selected the target and fired.

In addition to the Hustler's fire control, its defensive avionics suite was the AN/ALR-12 radar-warning system, the AN/ALQ-16 radar-jamming system—which was designed to confuse enemy ranging systems—and an AN/ALE-16 chaff dispenser. Also in the defensive array was the AN/APX-47 "Identification Friend or Foe" (IFF) communicator.

One of the more interesting problems encountered in aiming and operating the T-171E gun was that the forward motion of the aircraft at Mach 2 was actually faster than the muzzle velocity of the gun, so, theoretically, as a round left the barrel, it would actually be traveling backward relative to the ground. An interceptor pursuing the B-58 at that speed would actually have to run into the cannon shells rather than vice versa.

The B-58's gun was never fired in anger.

CHAPTER SEVENTEEN

DEPLOYING THE B-58 HUSTLER

An operational B-58A flies on patrol. Note the orange striped air refueling guidance markings painted on the anti-glare panel ahead of the aircraft's windshield. (Convair via Author's collection)

The B-58 was the last of the three Air Force Convair deltas to become operational. It reached squadron service in 1960, as the Strategic Air Command took over executive responsibility for the B-58 program on 1 August. This transition was to have occurred in 1959, but the high accident rate in the test program during 1959 and early 1960 led to the delay.

The delays had also led to the reduction in the number of B-58s delivered to the Command. At various points in the planning, varying numbers of operational wings were discussed, but just two wings of three squadrons each would become B-58 operators. The Strategic Air Command's commander, Gen. Thomas Power, reportedly wanted a third wing established at Little Rock AFB in Arkansas, and planning proceeded accordingly. However, the wing actually activated there was moved from Carswell AFB in Texas, rather than being a new wing. Both of the Hustler wings would eventually contain three medium bombardment squadrons, each of them equipped with 12 bombers.

The first Strategic Air Command unit to have any contact with the Hustler program was the 3958th Operational Test & Evaluation Squadron, created at Carswell AFB, which was conveniently located directly across the runway from the Convair Fort Worth factory where the Hustlers were being built. The base had previously been home to the Convair B-36s of the 7th Bomb Wing that had also been produced at Convair's Fort Worth facility.

The 3958th was activated in March 1958, more than a year after the B-58's first flight, but two years before the first official delivery of the Hustler to an operational unit. The unit, in turn, became the 3958th Combat Crew Training Squadron, which was officially absorbed by the 43rd Bombardment Wing in March 1960.

At the same time, in March 1960, the 43rd, then commanded by Col. James K. Johnson, became the first operational unit to receive the B-58. The 43rd, which had been stationed at Davis-Monthan AFB near Tucson, Arizona, was deliberately relocated to Carswell AFB in order to be close to Convair's Fort Worth facility. The 43rd was originally formed in November 1940 as the 43rd Bombardment Group, with the 63rd, 64th, and 65th Bombardment Squadrons and the 13th Reconnaissance Squadron assigned to it. Activated in January 1941 at Langley Field, Virginia, its wartime activities began nearly a year later and consisted of patrol missions along the Eastern Seaboard. Between February and August 1942, the assigned squadrons were sent to the Pacific Theater piecemeal, and the group became active as a B-17 unit within the Fifth Air Force in the autumn of 1942. The group took part in many important actions, including the Battle of the Bismarck Sea in 1943, and earned numerous awards, including the Philippines Presidential Citation.

Disbanded after World War II, the 43rd Bombardment Wing was re-established at Davis-Monthan AFB on 3 November 1947 as the 43rd Bombardment Wing, Very Heavy, a designation implying that it operated Boeing B-29 Superfortresses. On 1 August 1948, when the B-29 was redesignated as a "medium" bomber, the 43rd was redesignated as a "Bombardment Wing, Medium." Subsequently, Boeing B-50 "Super" Superfortresses and Boeing B-47 Stratojets were also assigned. It is worth noting that the 43rd Bombardment Wing "owned" the B-50, *Lucky Lady II*, which made the first ever non-stop, round-the-word flight in 1949.

Initially, the 43rd Bombardment Wing was assigned to the Eighth Air Force, but it was transferred to the Fifteenth Air Force in April 1950. Both of these Air Forces were components of the Strategic Air Command. Technically, the 43rd Bombardment Wing was used by the

This comp for a Convair print ad, circa 1960, includes the Strategic Air Command shield and a painting of a handsome young officer, presumably the archetypical B-58 pilot. He is posed holding his helmet, with a pair of Hustlers in the background against a world map that illustrates the global reach of the command and its bombers. The engineering drawing on the desk suggests that the ad copy would have discussed Convair's peerless engineering capabilities. (Convair via Author's collection)

Strategic Air Command for strategic bombardment training, and this function would continue as the wing made the transition to Hustlers.

From March 1960 to July 1961, the wing conducted Category II and III evaluations of B-58s—including the TB-58s and RB-58As—while operating a combat crew training school to train Strategic Air Command aircrews in Hustler operations. The evaluations continued through to July 1962, at which time the 43rd Bombardment Wing became operational.

The 43rd's three original bomb squadrons—the 63rd "Sea Hawks," the 64th, and the 65th "Lucky Dicers"—all were operational as medium (B-58) bomb squadrons. A fourth World War II–era squadron, the 403rd "Mareeba Butchers" Bombardment Squadron, was never a B-58 unit.

The second Hustler wing, the 305th Bombardment Wing, received its first B-58 in May 1961, 14 months after the first Hustler was delivered to the 43rd Bombardment Wing.

The 305th had originated during World War II as the 305th Bombardment Group, which was activated at Salt Lake City Army Air Base, Utah, in March 1942. After training at various locations in the United States, the 305th was sent to England in September 1942 as a B-17 heavy bomber component of the USAAF Eighth Air Force. Its first mission against the enemy came on 17 November. The commander of the 305th through May 1943 was then-Col. Curtis LeMay, who later, as a four-star general, would command the Strategic Air Command at the time the B-58s were assigned to the 305th. The group's wartime bases were at Grafton Underwood and Chelveston in southern England. In July 1945, the 305th was transferred to the Ninth Air Force and moved to St. Trond, Belgium, where it was involved in the *Project Casey Jones* aerial mapping survey of Europe and North Africa.

The 305th was officially inactivated on Christmas Day 1946, but re-established as a medium bomb wing on 20 December 1950 and activated two weeks later at MacDill AFB, Florida, for the purpose of training B-29 crews for operations in Korea. Conversion to the status of an operational B-47 unit began late in 1952, and the wing made three overseas deployments to Europe and North Africa through 1957 as part of the Strategic Air Command's demonstrations of global readiness.

In June 1959, the wing's home base was relocated to Bunker Hill AFB (Grissom AFB after May 1968) in Indiana, where its Hustlers would be assigned to its constituent 364th, 365th, and 366th Bombardment Wings. In 1966, the 3rd Airborne Command & Control Squadron was attached to the 305th. It would operate EC-135s in the Post-Attack Command & Control System (PACCS) mission. These aircraft would have had the grisly task of conducting the post-mortem in the event of a B-58 strategic attack against the Soviet Union.

While the B-58 had been designed initially for nuclear strike missions to be conducted at altitudes from 35,000 to 55,000 feet, advances in Soviet radar and surface-to-air missiles led to new tactics. Thus, in

A B-58A approaches the KC-135 tanker for the top-off that will give the Hustler its intercontinental range. Released in May 1961, this photograph is courtesy of the 1365th Photo Squadron at Offutt AFB, Strategic Air Command Headquarters, Nebraska. (U.S. Air Force)

The klaxon sounds, and the Alert Force race to their Hustler with the lights of their 1959 Ford Country Squire flashing. This is only a drill—repeat, only a drill—but had it been the real thing, this is how the Strategic Air Command's Hustler crews would have gone to war. (U.S. Air Force)

Capt. William Polhemus, Capt. Raymond Wagener, and Maj. William Payne took Firefly to the Paris Air Show on 26 May 1961. The 43rd Bombardment Wing crewmen made the flight from New York to Paris in less than 3 hours, 40 minutes, averaging 1,089 mph. Quite a contrast to the very first flight ever made non-stop between New York and Paris in May 1927 which took 33 1/2 hours! (U.S. Air Force)

addition to training for the original high-altitude scenario, Strategic Air Command B-58 crews also conducted training for supersonic low-level strike missions.

One of the most remembered operational missions ever undertaken by the Hustler was a low-level photoreconnaissance mission. This involved surveillance of the damage caused by the March 1964 Alaska Earthquake, which was then the strongest earthquake yet to occur in the United States. Flying below cloud cover at 500 feet, two B-58As were able to complete the mission so quickly that the finished photography was available for review in Washington, D.C., just 14 hours after the aircraft had been assigned the task.

The Hustler proved reliable in high-speed low-level operations where structural stress was a potential problem. The aircraft was constructed of aluminum honeycomb with a chemically bonded aluminum skin, which was designed to make it remarkably light and rigid. It had the highest ratio of payload weight to overall gross weight of any bomber yet placed in service, yet it had the structural rigidity to withstand routine operations at Mach 2 to Mach 2.2 speeds—as well as in the turbulent air at low altitudes.

During the early years of the B-58's operational career, it was used for a number of record-breaking flights, which demonstrated its capabilities and its potential. These were also seen as good public relations for the Air Force and for Convair. On 23 March 1960, shortly after the initial Strategic Air Command delivery, a B-58A crewed by Lt. Col. Leonard Legge, Capt. Andrew Rose, and Capt. Raymond Wagener, conducted an 18-hour, 11,000-mile flight that ranks as the longest Hustler flight ever made.

On 12 January 1961, the B-58 began a year in which it established a number of important world speed and payload records. On this date, under *Operation Quick Step I*, Maj. Henry Deutschendorf, Jr. (the father of singer John Denver), with Capt. William Polhemus, and Capt. Raymond Wagener of the 43rd Bombardment Wing, established six such records, including a speed record of 1,061 mph over a 2,000-kilometer (1,242-mile), closed-circuit course and 1,200.194 mph over a 1,000-kilometer (621-mile) course. Both records were set with a 2,000-kilogram (4,400-pound) payload.

Two days later, Lt. Col. Harold Confer, Lt. Col. Richard Weir, and Maj. Howard Bialas

This excellent head-on detail view of a B-58A was taken at Edwards AFB in October 1961, a few months after the Operation Quick Step I record-setting flights. (U.S. Air Force)

earned the Thompson Trophy for carrying a 2,000-kilogram (4,400-pound) payload over a 1,000-kilometer course at 1,284.73 mph in the B-58A known as *Road Runner*.

On 10 May 1961, a 43rd Bomb Wing B-58A (59-2458) flying out of Edwards AFB and crewed by Maj. Elmer Murphy, Maj. Eugene Moses, and 1st Lt. David Dickerson captured the esteemed Bleriot Trophy with a sustained speed of 1,302.07 mph over a 667-mile

On 14 January 1961, during Operation Quick Step I, the B-58A (59-2441) known as Road Runner, earned the Thompson Trophy for carrying a 2,000-kg (4,400-pound) payload over a 1,000-kilometer (639.957-nautical mile) course at 2,379.32 kph (1,284.73 mph). The crew for this historic flight was Lt. Col. Harold Confer, Lt. Col. Richard Weir, and Maj. Howard Bialas. (Author's collection)

TEXT OF A CONGRATULATORY TELEGRAM DELIVERED TO CONVAIR

Edwards AFB CALIF 11 1143A PST
Convair ATTN Ned Root
3165 Pacific Highway San Diego, CALIF

Unclassified FTN-11-1-2-E. For your information following is quoted: "From General Thomas S. Power, Commander-in-Chief of Strategic Air Command: The major significance of these B-58 record flights is that they have dramatically proved the capabilities of Strategic Air Command's first operational supersonic bomber.

"The Combat-ready Strategic Air Command crews, which achieved these marks in Hustler aircraft, have vividly demonstrated that the B-58 may be counted on to conduct successful bombing missions against enemy targets in the event of war.

"The B-58, which won the bombing title in the 1960 Strategic Air Command combat competition, is the U.S. Air Force's latest addition to its growing counterforce capability.

"I would like to extend congratulations and appreciation to the record-setting crews for outstanding performances."

— Charles A. Brown, Colonel, U.S. Air Force Director of Information, (Telegram, dated 11 January 1961)

Firefly, a B-58A assigned to the 43rd Bomb Wing, earned the highly prized Bleriot Trophy on 10 May 1961 for flying at a sustained speed of 1,302.07 mph over a 667-mile course. (Convair via Author's collection)

course. Louis Bleriot, the noted French aviator who was the first man to fly the English Channel, had established the trophy in 1930 to be awarded permanently to any aircraft flying for at least a half-hour at an average speed of 2,000 kilometers per hour (1,243 mph).

Two weeks after that, on 26 May, it was time for the Strategic Air Command to display its new prize performer at the most prestigious of all aviation gatherings, the Paris Air Show. On that date, the B-58A *Firefly* (59-2451), commanded by Maj. William Payne and crewed by *Quick Step* veterans Polhemus and Wagener, flew from New York to Paris in a record time of just under 3 hours, 40 minutes, averaging 1,089 mph. This flight earned the crew and the Hustler both the Harmon Trophy and the McKay Trophy.

The return flight on 3 June was scheduled to be flown by the Bleriot Trophy-winning team of Murphy, Moses, and Dickerson. Shortly after they took off, however, the crew attempted a low-level maneuver that fell victim to a flight instrumentation problem when

Displayed at the Paris Air Show in 1961,* Firefly *was the most celebrated of all the Hustlers in the fleet—but only for a brief moment. The aircraft crashed at Le Bourget Airport in Paris, due to instrument failure, while performing a slow roll during a low-level fly-by on 3 June, killing the Bleriot Trophy–winning team of Maj. Elmer Murphy, Maj. Eugene Moses, and 1st Lt. David Dickerson. (Convair via Author's collection)

Capt. Gerard Williamson, Maj. John Barrett, and Maj. Sidney Kubesch of the 305th Bomb Wing on the ramp at Bunker Hill AFB in Indiana. In the background is* Greased Lightning, *the B-58A in which they flew across the arctic from Tokyo to London at an average speed of 938 mph in October 1963. (U.S. Air Force via David Menard)

A 305th Bomb Wing B-58A Hustler on alert at Bunker Hill AFB in Indiana. (Ken Buchanan via David Menard)

the aircraft did a slow roll and unintentionally entered a fog bank. *Firefly* crashed, inverted on a farm adjacent to Le Bourget, and all three crewmen were killed.

As the B-58As were entering squadron service with the Strategic Air Command, they continued to set new speed records. On 5 March 1962, a Hustler crewed by Capts. Robert Sowers, Robert MacDonald,

OPERATIONAL HUSTLER STRATEGIC BOMBER UNITS

3958th Operational Test & Evaluation Squadron
(later 3958th Combat Crew Training Squadron)
Carswell AFB, Texas, 1958–1960

43rd Bombardment Wing (Strategic Air Command)
Carswell AFB, Texas, 1960–1964
Little Rock AFB, Arkansas, 1964–1970

Constituent B-58 squadrons

63rd Bombardment Squadron "Sea Hawks"
64th Bombardment Squadron "Lucky Dicers"
65th Bombardment Squadron
13th Reconnaissance Squadron
3958th Combat Crew Training Squadron
305th Bombardment Wing (Strategic Air Command)
Bunker Hill AFB (Grissom AFB after May 1968), Indiana, 1961–1970

Constituent B-58 squadrons

3rd Airborne Command & Control Squadron (EC-135)
364th Bombardment Squadron
365th Bombardment Squadron
366th Bombardment Squadron

THE RISE AND DECLINE OF OPERATIONAL B-58S IN THE STRATEGIC AIR COMMAND INVENTORY

Date	Number of B-58s	Proportion of the total SAC force*
December 1960	19	1.0 percent
December 1961	66	4.0 percent
December 1962	76	4.5 percent
December 1963	86	5.7 percent
December 1964	94	7.8 percent
December 1965	93	11.5 percent
December 1966	83	12.0 percent
December 1967	81	12.1 percent
December 1968	76	11.6 percent
December 1969	41	7.5 percent
December 1970	0	0 percent

* Excluding tankers and transports

B-58As stand alert with the 43rd Bomb Wing at Carswell AFB in Texas. For June 1963, the wing was celebrated as the "Outstanding Unit" in the Air Force. The following year, the 43rd was transferred to Little Rock AFB in Arkansas. (U.S. Air Force)

B-58 ACCIDENTS BY YEAR 1956–1970

Year	Fatal Accidents	Fatalities	Non-fatal Accidents
1956	0	0	0
1957	0	0	0
1958	1	1	0
1959	3	5	0
1960	2	5	0
1961	1	3	1
1962	3	7	1
1963	1	2	0
1964	1	1	0
1965	3	2	1
1966	1	3	0
1967	2	4	1
1968	1	3	1
1969	0	0	2
1970	0	0	0

and John Walton set a U.S. transcontinental speed record of 1,214.71 mph eastbound from Los Angeles to New York, and 1,081.77 mph on the return. The round trip took 4 hours 41 minutes, less time than a commercial one-way flight, even to this day. The previous record set for the flight had been by a McDonnell F-4 Phantom, and the latter leg of the flight was notable for having been the first ever completed in a faster time than the rotation of the earth.

On 18 September 1962, the Hustler won its second Harmon Trophy in as many years when an aircraft crewed by Maj. Fitzhugh "Fitz" Fulton, Capt. W. R. Payne, and Convair flight-test engineer C. R. Haines carried a 5,000-kilogram (11,000-pound) payload to an altitude of 85,360.84 feet.

In October 1963, a 305th Bomb Wing Hustler crewed by Maj. Sidney Kubesch, Maj. John Barrett, and Capt. Gerard Williamson—in an aircraft appropriately nicknamed *Greased Lightning*—flew from Tokyo to London at an average speed of 938 mph to set yet another speed record. This flight, in addition to being a record flight, was seen as tactically important because it demonstrated the B-58's range capability in Arctic airspace where operational missions would have been flown in the event of a nuclear war.

THE HUSTLER ACCIDENT RATE

No discussion of the Hustler's record-setting successes would be complete without mention of the B-58's other, darker side. Of the 116 that were built, 21 of them, or 18 percent, crashed. An additional five were destroyed or damaged in ground accidents, and only one of the damaged ones was repaired. There were 33 flight crewmembers and two ground crewmen killed.

The aircraft loss rate remained relatively constant through the entire service life of the B-58. With three exceptions, there were two or three aircraft lost every year from 1959 through 1969, the last full year of service. The exceptions were 1963 and 1964, when only a single Hustler was lost each year, and 1962, when there were four aircraft losses and seven crewmen killed in three fatal incidents.

Systems malfunctions, mainly in the control systems, were the leading cause, accounting for 11 B-58 losses, and possibly a twelfth. Landing-gear or tire problems were responsible for three aircraft losses and one Hustler was lost in 1961 due to an engine flameout. Weather was a factor in two incidents in 1960 and 1967. The single damaged Hustler to be restored to flight status had suffered a structural failure during taxiing in 1967.

Pilot error was the principal factor in six losses, five of them between 1963 and 1966. Of these, two involved hard landings, two involved missing the runway, and one occurred during low-level training operations.

The B-58 also had the dubious distinction of having suffered not one, but two, fatal crashes at the Paris Air Show. The first, which is discussed above, occurred in 1961, and the second happened in the June 1965 incident when the crew undershot the runway at Le Bourget Airport.

ANNUAL FLIGHT SAFETY STATISTICS

Last updated 23 March 2005

YEAR	NON -RATE	CLASS A		CLASS B		DESTROYED AIRCRAFT		FATALITIES		FLIGHT HOURS	
	Count	Count	Rate	Count	Rate	Count	Rate	Pilot	Total	Year	Cum
CY58	0	1	840.34	2	1,680.70	1	840.34	1	1	119	119
CY59	0	2	264.55	1	132.28	2	264.55	0	0	756	875
CY60	0	2	89.25	0	—	2	89.25	0	0	2,241	3,116
CY61	0	2	21.96	0	—	2	21.96	1	1	9,108	12,224
CY62	0	4	24.91	5	31.13	4	24.91	2	2	16,060	28,284
CY63	0	1	3.54	2	7.08	1	3.54	0	0	28,259	56,543
CY64	0	0	—	1	3.14	0	—	0	0	31,834	88,377
CY65	0	3	9.91	1	3.30	3	9.91	1	1	30,271	118,648
CY66	0	1	3.24	1	3.24	1	3.24	1	1	30,882	149,530
CY67	0	2	7.41	1	3.70	2	7.41	1	1	27,002	176,532
CY68	0	2	7.95	0	—	2	7.95	1	1	25,157	201,689
CY69	0	2	10.01	0	—	2	10.01	0	0	19,983	221,672
CY70	0	0	—	0	—	0	—	0	0	256	221,928
LIFETIME	0	22	9.91	14	6.31	22	9.91	8	8	221,928	221,928

Aircraft destroyed per 100,000 flight hours 9.913124977

CHAPTER EIGHTEEN

THE OTHER "HUSTLERS"

No doubt, many of the milestones reached by Convair engineers in the B-58 program played a part in the development of the NX-2, Convair's proposed nuclear-powered bomber that was planned but never built. For this application, Convair abandoned the delta wing in favor of the futuristic "hood ornament" look. (Convair via Author's collection)

Though only the "A" production model was built, both a B-58B and a B-58C were considered, and one B-58B aircraft was ordered. These would have had larger weapons pods and provisions for additional weapons, including ALBMs. In addition, different engine configurations and side-by-side seating for the pilot and the bombardier-navigator were also studied.

The B-58B would have been powered by an uprated version of the General Electric J79 turbojet, designated as J79-GE-19. This aircraft would have had canard control surfaces mounted forward of the wing that were similar to, but smaller than, those seen on the XB-70. The single B-58B was canceled shortly after it was ordered in 1960, although production metal was cut for some components.

An aircraft larger than the B-58A or B-58B, the B-58C (also known as BJ-58), was conceived in part as Convair's proposed alternative to the North American Aviation XB-70. In retrospect, it would have been an amazing aircraft, powered by the same 32,500-pound-thrust Pratt & Whitney J58 turbojet engines that Lockheed used for the YF-12/SR-71 series. Like the SR-71, the B-58C would have hit speeds in the Mach 3 environment, and would have cruised at Mach 2 and above 70,000 feet.

As with the XB-70 program, the idea of developing a B-58C was a victim of the Defense Department's decision that fast, high-altitude penetration bombers were a thing of the past. The B-58C died in 1961 with no such aircraft having been funded or built.

Less fully evolved were studies for the B-58D and the B-58E, and these designations were not officially assigned. Both were efforts by Convair to adapt the B-58 for roles other than that of a strategic bomber. The twin-engine B-58D concept was Convair's answer to the need for a longer-range, supersonic interceptor similar to the Lockheed YF-12. The B-58E, also proposed with two engines, was a tactical bomber. If the B-58A were a medium-range strategic bomber, the range of the B-58E would have seemed long in the context of a tactical mission.

The tactical B-58E was a child of the 1960s, undertaken at the time that the Defense Department was exploring its controversial "Tactical Fighter, Experimental" program, best remembered by the acronym "TFX." This project was a failed attempt to build one aircraft that could function as both fighter and bomber for both the Air Force and the Navy. Ultimately, the TFX was built only as a bomber (although it carried the "F for fighter" designation), and only for the U.S. Air Force. Designated as F-111 and FB-111, these aircraft were products of Convair's parent company, General Dynamics, and were manufactured on the same Fort Worth assembly line as the B-58A Hustlers.

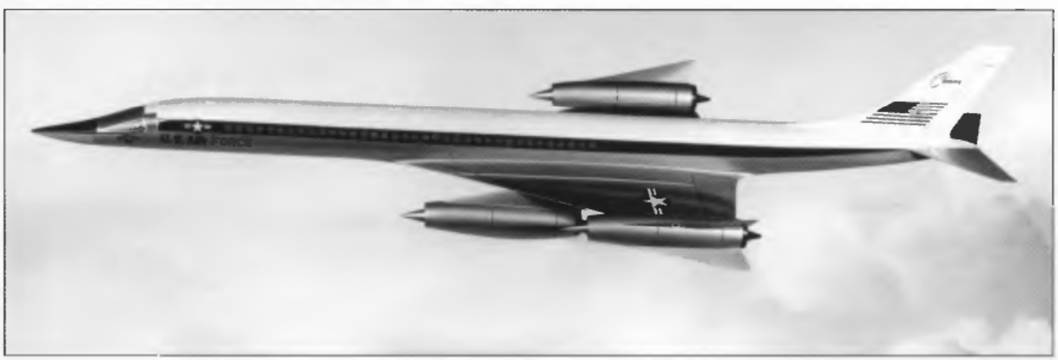
Even as the basic Hustler airframe was being considered in various configurations, Convair was studying the concept of a "Super Hustler," with a performance envelope significantly better than that of the B-58A. As noted earlier, it was axiomatic in the weapons planning paradigm of the 1950s that an aircraft's successor should be on the drawing board by the time that it made its first flight. Such was the case with the Super Hustler, which was considered even before the B-58A was deployed.

Early in 1957, the Mach 4 Super Hustler was a distinctly different aircraft and a distinctly different concept. It was significantly smaller, and much faster than a B-58A, and it was initially intended to be air-launched from a B-58A. When the B-58 "mother ship" had achieved a speed of Mach 2 at a predetermined distance from the target, the Super Hustler parasite would fire up its ramjet engines and separate from the host vehicle.

In this air-launch scenario, the size of the aircraft was governed by the need for the Super Hustler to fit under the Hustler's fuselage with the same ground clearance as the MB-1C weapons pod. Various Super Hustler configurations were studied, most of them involving a multi-stage vehicle composed of two or three dart-shaped vehicles between 40 and 50 feet in length, or slightly shorter than a Convair F-102. A two-man crew would sit side-by-side in one vehicle, while the second and/or third component would be a powered fuel and/or weapons section(s) that could be jettisoned.

Though the Super Hustler was never built, it evolved into the *Project Kingfish* reconnaissance proposal. Just as an interceptor derivative of the B-58 was passed over in favor of the Lockheed YF-12A, the Kingfish was rejected in favor of the YF-12A's nearly identical sister, the SR-71.

Not all of the projects that Convair engineers imagined could flow from the Hustler were military aircraft. In fact, there was even a commercial spin-off from the B-58 that was considered by the company.



It was only natural for Convair to consider a transport version of the Hustler. In 1961, when this model photo was released, everyone in the United States was talking about the impending age of supersonic transport (SST), and Convair already had a large supersonic aircraft upon which to base such a viable passenger airliner. (Convair via Author's collection)

The Convair SST proposal evolved to the Model 58-8, which is seen here in USAF markings. It was presumed that the Air Force would have a need for a means of transporting 52 high-level military or government personnel over long distances very quickly, although the Air Force never took Convair up on this suggestion. (Convair via Author's collection)

If one strolled the halls of any American aircraft company during the 1960s, one of the things that would have been overheard was the buzz about the notion of the supersonic transport (SST). It was predicted—even assumed—that commercial air travel at speeds greater than sound would be as routine before the end of the 1970s as subsonic jetliner travel was before the end of the 1960s. Design studies for aircraft to make this possible were a high priority at Boeing, Douglas, Lockheed, North American, and, of course, Convair.

Early in the 1960s, both North American Aviation and Convair had something of a head start insofar as both companies had practical experience with actual, large supersonic aircraft—the XB-70 and the B-58, respectively.

Convair's Hustler-derived SST was developed under the company designation Model 58 (the B-58 was the Convair Model 4). The ultimate Model 58 proposal was the Model 58-9. The "Dash 9" would use the same wing and tail as the Hustler, although Pratt & Whitney J58 turbojet engines were specified as substitutes for the General Electric J79s.

At the same time that the Model 58 program was on the drawing board at Convair in Fort Worth, the company's San Diego facility was producing and flight-testing two subsonic jetliners, the Convair 880 (Model 22) and the Convair 990 (Model 30). The people involved in these two programs, with first flights occurring in 1959 and 1961, respectively, had little contact with the people engaged in the Hustler program in Texas, and the jetliners had minimal influence on the design of the Model 58.

Because the Hustler had been designed for the performance envelope imagined for the Model 58, the latter's fuselage was to have been a stretched Hustler fuselage, rather than a passenger cabin borrowed from either the 880 or the 990. As such, it would have been only 80 inches wide, or about half the width of its commercial cousins. This would have permitted no more than two-abreast seating, as contrasted with the five-abreast configuration of the 880 and 990. As a footnote, it is worth mentioning that the 880 and 990 were, themselves, narrower than their competitors, the Douglas DC-8 and Boeing 707, which offered the six-abreast seating that would become the industry standard.

To compensate for the narrowness of the fuselage, the pencil-like fuselage of the Model 58 was designed to be longer than either of the Convair jetliners. The Hustler's 96-foot, 9.4-inch fuselage would be stretched to 150 feet in length in the Model 58. This compared to 129 feet 4 inches for the 880, and 139 feet 5 inches for the 990.

These dimensions would have given the Model 58 a passenger capacity of 52, compared to maximums (in all-economy configuration) of 130 and 149, respectively, for the 880 and 990. Even assuming that the 52 passengers would pay extra for the supersonic speed, the economics of the Model 58 were more of a stretch than its fuselage length.

The only American SST on which metal was to be cut was the Boeing 2707, which would have accommodated more than 250 passengers, depending on configuration. The Anglo-French Concorde, the only SST ever to see consistent, long-term service, had a passenger capacity of only 100 passengers.

The Convair Model 58 program never went beyond the design studies. As it turned out, the company lost so much money on the 880 and 990, that these would be the last production aircraft of any kind that the company would ever build.

The Convair Model 58-9, presumably the ultimate Convair SST proposal, could have given the President of the United States a supersonic Air Force One by around 1970, the middle of Richard Nixon's first term. Much like the positive legacy that Nixon imagined for his presidency, the Model 58-9 never happened. A commercial version might have carried as many as 78 passengers in three-abreast seating, but it would have been cramped, noisy, and very expensive. (Convair via Author's collection)

Chapter Nineteen

The Later Career of the B-58 Hustler

The Bleriot and Bendix Trophy-winning former 43rd Bomb Wing B-58A (59-2458), known as Cowtown Hustler, arrives at Wright-Patterson AFB for permanent display at the National Museum of the Air Force. (David Menard)

The decade during which the B-58 Hustler was in service with the Strategic Air Command was one of big change, both for the command and for strategic doctrine. It was the decade when manned bombers gave way to ICBMs as the leading edge of nuclear force projection for both the United States and the Soviet Union. ICBMs were in their technological infancy when the 1960s began, and they were widely deployed when the decade ended. This greatly altered the relative value of a Mach 2 strategic bomber.

The Strategic Air Command itself, after nine years under the command of Gen. Curtis LeMay (1948–1957), was one of the most powerful single nuclear strike forces in the world, but during the 1960s, part of its fleet was deployed to fly non-nuclear missions in Southeast Asia. The Command's contribution to the war included KC-135 tankers and early-model B-52D bombers, but not the supersonic B-58. The latter was not included in the Air Force order of battle because its supersonic speed was unnecessary, and the B-52D had both a greater unrefueled range and a huge conventional bomb capacity. Indeed, the B-58 had been specifically designed *not* to possess a conventional bomb-carrying capacity. Its MB-1C nuclear weapons pod was part of the design of the aircraft itself.

Southeast Asia found U.S. forces in the type of war for which American military planners had focused little attention during the 1950s. As a result, the United States found itself adapting high-tech weapons to low-tech operations—much as it would in *Southwest* Asia a generation later. For the U.S. Air Force, this meant adapting nearly every aircraft in its inventory to fit a role in unanticipated combat operations. Even the B-58 was considered, although the conventional story is that it did not serve.

Though the Air Force had never given much thought to such an idea either before or during 1967, its *Project Bullseye* studied the feasibility of using the B-58 with conventional high-explosive ordnance. This scenario had been the subject of a short-lived proposal that Convair had made to the Australian government nearly a decade earlier, but the U.S. Air Force had never seriously considered it prior to the years of its peak involvement in Vietnam.

Under *Bullseye*, the four external hard points that had earlier been retrofitted for additional nuclear weapons were adapted for conventional iron bombs. Up to 3,000 pounds of such weapons were dropped in successful low-level tests flown out of Eglin AFB in Florida.

In simulated strike missions—which reportedly involved at least one B-58 painted in Southeast Asia camouflage colors—Hustlers flew both pathfinder operations with other strike aircraft and solo bombing missions. Almost all of the drops were visual, with the AN/ASQ-42 system rarely used.

Because of their speed and maneuverability, the Hustlers were found suitable in the conventional role. However, the fear that the B-58's integral wing tanks would make it vulnerable to ground fire during low-altitude attacks led to the abandonment of the *Bullseye* program. Another reason for the Hustler not being deployed was, reportedly, because the Defense Department feared the negative publicity that might come with the loss of a B-58 on a tactical mission.

The question of whether at least one B-58 might have actually deployed to Southeast Asia has been widely discussed in the years since. Officially, no B-58 was ever painted in Southeast Asia camouflage colors, and no B-58 was ever operational in that theater. However, David Menard, who was on active duty from 1955 through 1977, and employed at the U.S. Air Force Museum at Wright Patterson AFB in Ohio from 1978 to 1999, reports that he met several fellow maintenance troops over the years who saw the camouflaged B-58, either at Eglin AFB or at Little Rock AFB. He also met an officer who, as an ROTC cadet, made a wrong turn on a back road at Little Rock AFB and wound up behind the alert area where he saw it too. Menard also spoke with an F-105 pilot whose unit was tasked with obtaining radar images for the B-58 bombing-navigation system in preparation for its deployment in Southeast Asia. To date, no photograph of such an aircraft has ever surfaced, although in general, the Strategic Air Command was always very touchy about having its equipment photographed.

By the late 1960s, the B-58's days were already numbered. In December 1965, just 26 months after the final B-58A delivery, United States Secretary of Defense Robert McNamara had ordered the Strategic Air Command to plan for the phase-out of the Hustler by the end of the decade. There would be no need for a supersonic bomber, McNamara reasoned, when intercontinental ballistic missiles could do the job.

Today, McNamara's tenure as Secretary of Defense is remembered mainly for two things. The first is the way he mishandled the Vietnam War, of which he said in his memoirs, "We were wrong, terribly wrong…I truly believe that we made an error not of values and intentions, but of judgment and capabilities." The other legacy of McNamara's tenure is the cancelation of many important milestone aerospace projects, programs that died before great potential could be realized. In 1961, McNamara terminated the production variant of the hypersonic North American Aviation XB-70 as well as the Douglas Skybolt ALBM. In 1963, he killed the Boeing X-20 Dyna-Soar, which could have flown in 1965 as America's first space shuttle. Next came the Hustler, although it had been operational for a time.

For its part, the Strategic Air Command, which had argued against the B-58 in the beginning, asserted that the B-58 should be retained—at least until 1974—to give the strategic service more flexibility in meeting the demands of its evolving mission.

McNamara stood by his decision, although it would be his successor, Melvin Laird, who would preside over the final termination of B-58 operations during the first year of Richard Nixon's presidency.

The decision to withdraw the B-58 from service has always been controversial. On one hand, the Hustler had achieved the design goals set for it and it was the fastest strategic bomber to serve with the U.S. Air Force. On the other hand, the Strategic Air Command had never fully embraced the Hustler because of its limited range, and its service career coincided with a serious debate within the Air Force over whether the role of nuclear deterrence was better performed by manned bombers or intercontinental ballistic missiles.

The YB-58 redesignated as an RB-58 that was used in the AIM-47 missile tests is seen here at Edwards AFB in September 1964. (W. M. Jefferies via David Menard)

Another important and inescapable issue was the cost—especially at the peak of the war in Southeast Asia—of maintaining an aircraft so sophisticated and with so many unique parts. Maintenance was inescapably complex and expensive, and it involved specially trained crews that were always in short supply. The engines, designed more for performance than durability, were also problematic, and thoughts of re-engining the Hustler fleet were not pursued because the Defense Department had already made up its mind to phase out the B-58.

Though there had been plenty of warning, the end of the B-58's career came rather abruptly. It was announced in October 1969 that both Little Rock AFB and Grissom AFB would be closed and that the entire B-58 fleet would be mothballed within only three months!

This process began within a few weeks of the announcement, and most of the roughly 80 surviving B-58s were flown to Davis-Monthan AFB in the six-week period between mid December and the end of January 1970. Here, they were put into indefinite storage at the Military Aircraft Storage & Disposal Center, better known as the Boneyard.

The 43rd Bombardment Wing was inactivated as a bomb wing at the end of January 1970 when the B-58s were withdrawn, but it was reactivated in April 1970 as an aerial refueling wing and designated as the 43rd Strategic Wing. As such, it replaced the 3960th Strategic Wing at Andersen AFB, Guam, flying KC-135s in support of B-52 Arc Light bombing operations in Southeast Asia. The 305th, also relieved of its B-58s and its strategic bombing mission in January 1970, became the 305th Air Refueling Wing.

For nearly six years, the bulk of the Hustler fleet rested in the high and dry Arizona desert, each aircraft theoretically ready to be restored to flying condition. Finally, in October 1976, the Defense Department officially sold them for scrap metal value at a sealed-bid auction. The fleet would last through the winter before finally being cut up between May and August 1977 by Tucson-based Southwest Alloys.

I recall having heard a story told at an Air Force function at Bolling AFB in Washington, D.C., in the early 1980s, which, if true, would thicken the plot of the B-58 disposition. The probably apocryphal tale was that when the Reagan Administration took office in 1981, the incoming Defense Department under Secretary Caspar Weinberger considered bringing the B-58 fleet out of retirement and retrofitting them with turbofan engines to augment the planned B-1B fleet. It was only after the plan won official approval that it was discovered that the previous Carter Administration had already disposed of the Hustlers!

Only four intact aircraft escaped the Boneyard. Three were dispersed to be preserved as museum pieces, being flown to the Strategic Air Command headquarters at Offutt AFB, Nebraska; Chanute AFB, Illinois; and the Air Force Museum at Wright-Patterson AFB, Ohio. The fourth remained behind at Grissom AFB as a permanent static display.

Two abandoned B-58 hulks that were deemed not worth moving also remained behind. One was a damaged aircraft at Little Rock AFB that was written off as not worth repairing, and the other was a discarded Air Research & Development Command test aircraft at Edwards AFB.

THE ULTIMATE DISPOSITION OF THE B-58 FLEET

Crashed	21
Lost in Ground Accidents	4*
Destroyed in Fatigue Testing	1
Scrapped	82
Preserved as Museum Pieces	6
Derelict	2
Total	116

*A fifth damaged B-58 that has often been listed as lost was repaired and put back into operation.

43rd Bomb Wing B-58A on an overwater mission on 20 April 1964. The Hustler never served in a maritime patrol role, but it could have been theoretically used for fast intercepts of Soviet submarines offshore during wartime. (U.S. Air Force)

Two of the Boneyard B-58s sold at the scrap auction were saved. One—interestingly, the last Hustler ever built—was purchased by the Pima County Air Museum. This private organization, located adjacent to Davis-Monthan AFB, is dedicated to preserving one each of the aircraft that pass through the Boneyard. The other was transported back to where it started to become part of the permanent collection of the Southwest Aerospace Museum at Fort Worth.

Today, the six aircraft that were intentionally preserved still remain, and the hulk at Little Rock AFB was moved to Barksdale AFB in Louisiana for restoration. The only theoretically flyable B-58 is the one located at the Air Force Museum, where an effort is made to maintain all aircraft in perfect, ready-to-fly condition. It has not, however, been flown in many decades, and it almost certainly will never undergo so much as an engine run-up. This aircraft is of particular importance, being the specific B-58A to have won the Bleriot Trophy.

These seven aircraft and one derelict are all that remain of one of aviation history's truly legendary aircraft.

Though it retired at a time of technologically lowered expectations, the B-58 was born in an era when the engineering prowess of American industry was perceived as being nearly omnipotent. Designed to meet an Air Force requirement for a strategic bomber capable of speeds in excess of Mach 2, the Convair Model 4 Hustler was the fastest such aircraft to reach squadron service outside the Soviet Union. Delivered under the service designation B-58, it first flew in 1956, entered service in 1960, and was retired in 1970. Aside from one operational reconnaissance mission flown over Cuba during the October 1962 Missile Crisis, the Hustler is not known to have participated in any operational missions within hostile airspace during its career with the Strategic Air Command.

As test pilot Beryl Erickson told Eric Hehs in his 1992 interview with *Code One* magazine, "General LeMay did not like the plane. The people who flew the plane, though, liked it. If I were to be offered a chance to fly the B-58 to heaven, I'd go right away. It was absolute pure joy to fly."

A hypothetical image of a B-58A wearing jungle camouflage and flying a low-level bombing mission against targets in North Vietnam, circa 1967 or 1968. Such missions were probably never flown but there are persistent rumors that at least one Hustler was painted in Southeast Asia camouflage, and that at least one served in combat. While these rumors may or may not be true, they provide one of the most enduring apocryphal legends about the B-58. (Artist's concept by Erik Simonsen)

This 43d Bomb Wing B-58A was nicknamed Lucky Lady V. It is seen here in May 1968 during a transient visit to Mather AFB in California. Note the tail of a Convair F-106A in the background at the extreme right. The Hustler had a rather prominent nose-down attitude when sitting on its landing gear, and the proportion of the weapons pod relative to the aircraft's fuselage length was more than half. Many enthusiasts have noted that the basic shape and overall proportions of the Convair B-58 can be detected in the profile of today's General Dynamics (now Lockheed Martin) F-16 Fighting Falcon. (Jay Sherlock via David Menard)

This YB-58 retrofitted as an RB-58 was used extensively in low-level test flights. Seen here in July 1965, it was later preserved at Chanute AFB in Illinois. (S. H. Miller via David Menard)

CONVAIR B-58 HUSTLER (MODEL 4) PRODUCTION CLOSE-UP

B-58-CF	2
B-58A-CF	11
B-58A-10-CF	36
B-58A-20-CF	20
B-58A-30-CF	30
RB-58A-CF	17
B-58B	(Canceled)
B-58C	(Canceled)
Total	116

Conversions

NB-58A-CF	1 (Converted from a B-58A)
TB-58A-CF	8 (Converted from B-58As)

A B-58 taking on fuel from a KC-135 in 1958. (U.S. Air Force)

CONVAIR B-58A HUSTLER (MODEL 4) SPECIFICATIONS

Dimensions
Wingspan: 56 feet 9.9 inches (17.3 meters)
Length: 96 feet 9.4 inches (29.5 meters)
Fuselage height (at pilot's hatch cover): 13 feet 9 inches (4.1 meters)
Tail height: 29 feet 11.1 inches (8.98 meters)
Wing area (less elevons): 1,364.7 square feet (126.9 square meters)
Total wing area: 1,542.5 square feet (143.4 square meters)

Weights (B-58A)
Empty: 55,560 pounds (25,225 kilograms)
Empty, with MB-1C pod: 64,115 pounds (29,110 kilograms)
Maximum gross: 176,890 pounds (80,300 kilograms)

Weights (TB-58A)
Empty: 52,400 pounds (23,800 kilograms)
Maximum gross: 158,000 pounds (71,700 kilograms)

Powerplant
4 General Electric J79-GE-5A or -5B turbojet engines rated at 9,700 pounds (4,400 kilograms) of continuous thrust, with a maximum thrust rating of 15,600 pounds (7,080 kilograms)

Performance
Cruising speed: 611 mph (984 kph)
Design maximum speed: Mach 0.9 (below 25,000 feet/7,700 meters) or Mach 2 (at 40,000 feet/12,000 meters)
Structural integrity maximum speed: Mach 2.2 (for short intervals)
Unrefueled ferry range: 4,715 miles (7,590 kilometers)
Cruising altitude: 38,450 feet (11,730 meters)
Target area altitude: 55,900 feet (17,050 meters)
Combat ceiling: 63,400 feet (19,337 meters)

Offensive armament
MB-1C weapons pod with a W39Y1-1 nuclear weapon; or a two-component pod "TCP" with a BA53-Y1 nuclear weapon; and/or four Mk.43 or Mk.61 nuclear bombs outside the pod on under-fuselage hard points

Defensive armament
General Electric T-171E (M61) six-barreled rotary cannon

A former 43rd Bomb Wing B-58A arrives at the Davis-Monthan AFB Boneyard in January 1970. (Becker Collection via David Menard)

An "elephant walk" to an "elephant's graveyard." Two long lines of Strategic Air Command B-58s at the Davis-Monthan AFB Boneyard in January 1970. Had they survived until 1981, they might have had another life. (Becker Collection via David Menard)

This B-58 survived the wrecker's ball and salvage yard at Davis-Monthan AFB, and is preserved today at the nearby Pima County Air Museum. The author photographed it in 1981 prior to its restoration. (Author photo)

A close-up view of B-58A 59-2458 at the National Museum of the Air Force, as photographed by the author in 1985. (Author photo)

THE ECLIPSE OF THE CONVAIR DELTAS

Tucking away its landing gear, an EXD-01 (QF-106) aircraft takes off from Mojave Airport. This airport is also home to a huge storage facility for unused commercial jetliners. (NASA Dryden Flight Research Center)

As the twentieth century neared its end, there would be one last curtain call for a Convair delta in the skies over North America. In 1997 and 1998, two QF-106s were reconfigured for *Project Eclipse,* a NASA demonstration program whose objective was to investigate the feasibility of using a towed aerial vehicle to access outer space. This concept was the brainchild of Mike Kelly, the founder of Kelly Space & Technology, based in Redlands, California. Kelly patented his "aerotow" concept in 1997 under the heading "Space Launch Vehicles Configured as Gliders and Towed to Launch Altitude by Conventional Aircraft."

The basic aerotow concept is not new. Powered aircraft have been used to tow gliders since the 1920s, and this is still the usual way that recreational and sport competition sailplanes are launched. During World War II, heavy transport gliders were widely used, and NASA used the aerotow method during the 1960s to launch various experimental aircraft, such as the M2-F1 lifting body.

Kelly took the concept a step further. His hypothesis was that using an aircraft to tow a launch vehicle to an altitude of around 35,000 feet would eliminate the need for large, expensive first-stage booster rockets that are the standard initial step in placing a payload into orbit. The function of the first stage is simply to get the payload off the ground. Theoretically, this could be done more efficiently by towing the spacecraft to the altitude where the first-stage booster is typically discarded and the second stage ignited.

A secondary advantage to the aerotow concept for accessing space is that the vehicle itself is aerodynamic, meaning that when it reenters the atmosphere, it can fly to an airplane-like landing and be reused. The idea of reusable winged spacecraft has been around for as long as people have been accessing space, but through the twentieth century, the only spacecraft that had demonstrated this capability on a routine basis was the NASA Space Shuttle.

In the operational scenario, it is envisioned that a launch vehicle

On 20 December 1997, the Kelly Space & Technology **Project Eclipse** ***EXD-01 (QF-106) and an Air Force Lockheed C-141A take off from Mojave, California, for the project's first tethered flight.*** (NASA Dryden Flight Research Center)

NASA photographer Tom Tschida captured Project Eclipse's modified EXD-01 (QF-106) as it lifted off under tow on the project's first tethered flight on 20 December 1997. (NASA Dryden Flight Research Center)

Pilot Mark Stucky in the NASA F/A-18 cockpit simulator at Dryden on 17 February 1998. The F/A-18 simulator was used for F-106 simulations during Project Eclipse. (NASA Dryden Flight Research Center)

The modified EXD-01 (QF-106) climbs out under tow by an Air Force C-141A. (NASA Dryden Flight Research Center)

Project Eclipse *EXD-01 (QF-106) under tow on the project's first tethered flight.* (NASA Dryden Flight Research Center)

As photographed by Tony Landis on 26 September 1996, these are the two QF-106s that were converted to piloted EXD-01s for the Eclipse program. They are seen here parked at the Mojave Airport in Mojave, California. (NASA Dryden Flight Research Center)

weighing about 160 tons would be towed aloft to a point high in the earth's atmosphere, where it would be detached from the tow aircraft, and its rocket boosters ignited. It would then travel into space to an altitude of about 75 miles to release its payload of one or more satellites, which would, in turn, be boosted into low earth orbit. The launch vehicle would then reenter the earth's atmosphere and land on a runway.

Project Eclipse was designed to demonstrate the aerotow concept, and not to actually place a vehicle into orbit. Kelly's objective was to prove that a large aircraft could be launched at high altitude after being towed there by another aircraft. As NASA described it, he chose the QF-106A as this candidate aircraft "to simulate a future launch vehicle because of its low-aspect ratio and relatively high wing loading."

The *Project Eclipse* tests took place at Edwards AFB under the auspices of NASA's Dryden Flight Research Center, located at the base. Dryden furnished engineering, instrumentation, and modification expertise to the project, while the Edwards-based Air Force Flight Test Center (AFFTC) provided two QF-106As as well as a crewed C-141A Starlifter to serve as the tow aircraft. When modified by Dryden for *Project Eclipse*, the two Delta Darts were redesignated as EXD-01 for Eclipse Experimental Demonstrator, First. Though two EXD-01s were created, only one was to be used. The second served merely as a backup and would not be flown unless something happened to the first.

EXD-01 modifications included restoring the controls to the former piloted configuration and fitting the aircraft with a heavy-duty tow apparatus mounted on the upper fuselage just forward of the canopy. In turn, the attachment point was anchored to major structural components of the EXD-01's fuselage. Part of the towline interface was a release mechanism that was fashioned from a B-52 drag chute. It was designed so that the tow cable could be released either by a button on the EXD-01's control stick or with a manual release handle. The towline consisted of a 1,000-foot stretch of 3/4-inch Vectran liquid crystal polymer that was tested to more than twice the expected load.

After extensive flight simulations, the EXD-01 made its first flight in formation with the C-141A in July 1997. The two aircraft flew independently in an untethered flight in order to evaluate the wake turbulence of the larger "mother ship" and to determine the proper separation distance for future, tethered flights. After a series of tethered taxi tests, the tethered flights began in December. In a series of six flights conducted through February 1998, the EXD-01 was

One of the two EXD-01 (QF-106)* Project Eclipse *aircraft taxiing on the runway at Mojave Airport on 12 February 1997. Piloted flights in formation with the C-141A preceded the tethered flights. (NASA Dryden Flight Research Center)

released at various altitudes between 10,000 and 24,000 feet, with the towline being released from both aircraft and allowed to fall to the ground.

The last flight of a Convair delta in the twentieth century—and probably ever—ended with the successful landing on 5 February 1998 at Edwards AFB, the same place where the Convair delta story had begun a half a century earlier on 9 June 1948 with Sam Shannon's "accidental" debut in the XF-92A.

When Jim Ross took this picture of the EXD-01 (QF-106) from a KC-135 tanker, the Project Eclipse aircraft was not refueling but simply flying below and behind the tanker for inflight photography purposes. (NASA Dryden Flight Research Center)

This EXD-01 (QF-106) used during Project Eclipse was photographed inflight from a KC-135 by NASA photographer Jim Ross on 12 February 1997. (NASA Dryden Flight Research Center)

This photograph shows the forward part of the EXD-01 (QF-106) and the relation of the position of the tow cable attachment and release mechanism forward of the cockpit. This mechanism held and then released the Vectran line connecting the EXD-01 to the C-141A. (NASA Dryden Flight Research Center)

Tony Landis took this close-up view of the release hook on the EXD-01 (QF-106) in September 1997. This is the apparatus that allowed the pilot to release the Vectran towline extending from the C-141A during **Project Eclipse's** ***tethered flights.*** (NASA Dryden Flight Research Center)

This great head-on shot of the EXD-01 (QF-106) aircraft in flight with the landing gear extended was taken by NASA photographer Carla Thomas in August 1997. (NASA Dryden Flight Research Center)

A look inside the EXD-01 (QF-106) cockpit, showing old-fashioned "steam gauge" round instruments that date back to this aircraft's first career as an interceptor in the 1960s. (NASA Dryden Flight Research Center)

The EXD-01 (QF-106) at the end of its Vectran towline on a 28 January 1998 flight over Edwards AFB. This aircraft is flying in the same airspace where the first F-106As were flight tested four decades earlier. (NASA Dryden Flight Research Center)

THE GENERAL DYNAMICS DELTA

The delta wing lived on in a General Dynamics delta that became a Lockheed Martin delta. The two-seat F-16XL (NASA aircraft number 848) as seen on 13 October 1995, during its first functional check flight after installation of the dark-laminar flow-control panel on the left wing. (NASA Dryden Flight Research Center)

The two-seat F-16XL as seen from an Air Force KC-135A refueling aircraft on 13 November 1996, during one of its final flights in NASA's Supersonic Laminar Flow Control program. (NASA Dryden Flight Research Center)

Outside the scope of this book, but clearly deserving of a mention, is the experimental delta-winged aircraft that was later developed by Convair's parent company, General Dynamics. As we have seen, Convair became a division of General Dynamics in 1954, but Convair's operations at both San Diego and Fort Worth continued seamlessly through the huge production years of the 1950s. However, after the last B-58 was delivered in 1961, General Dynamics reorganized its operations into regions. With this change, Fort Worth was disassociated both from San Diego, and from the Convair name. Thereafter, the two centers went their separate ways. In San Diego, Convair wound down its aircraft development activities entirely with the last deliveries of Model 990 jetliners and a prototype light attack aircraft, the Model 48 Charger that never entered production. Convair continued to build missile systems in San Diego for another three decades, as well as subassemblies and fuselage sections for McDonnell Douglas jetliners.

Meanwhile, high-performance jet aircraft development and production continued in Fort Worth, but aircraft built there now carried the General Dynamics, rather than Convair, name. The first such aircraft was the company's entry into the Defense Department's controversial Tactical Fighter, Experimental (TFX) program. This program failed in its intended goal of building an aircraft to serve the needs of both the U.S. Navy and U.S. Air Force, but it did evolve into the F-111 program, an aircraft type that functioned in a variety of roles in the latter service for many years.

The next major aircraft developed by General Dynamics in Fort Worth was the Model 401 lightweight multi-role fighter, which was designated as the F-16 by the Air Force. First flown in 1974, the YF-16 prototype went on to win a fly-off competition with the Northrop YF-17 earning a very lucrative late–Cold War aircraft production contract. One of the most successful American combat aircraft of the last quarter of the twentieth century, the F-16 went on to serve not only with the U.S. Air Force, but the Navy and two-dozen international air forces.

The single-seat F-16XL (NASA aircraft number 849) is seen here on 16 December 1997, during the first flight of the Digital Flight Control System (DFCS) test program. (NASA Dryden Flight Research Center)

What earned the F-16 a place as a postscript in this book is not the many hundreds that continue to be built with the standard swept-wing configuration, but the unique F-16XL "cranked arrow" compound delta-winged variant, of which only two were built.

The F-16XL evolved out of the Supersonic Cruise and Maneuver Prototype (SCAMP) program of 1977. In this project, General Dynamics worked with NASA's Langley Research Center to adapt supersonic transport (SST) technologies to military aircraft. Wind-tunnel tests led the research team back to a place where Convair had gone four decades earlier—the delta wing. In 1981, when the Air Force initiated its Enhanced Tactical Fighter program to develop a fighter-bomber replacement for the General Dynamics F-111, General Dynamics proposed the F-16XL. For evaluation purposes, the company built two aircraft, a single-seater that first flew on 3 July 1982, and a two-seater that first flew on 29 October of that year. These aircraft were flown in competition with a two-seat variant of the McDonnell Douglas F-15 Eagle, which was declared the winner of the Enhanced Tactical Fighter program in February 1984. As the McDonnell Douglas aircraft entered service as the F-15E Strike Eagle, the two F-16XL aircraft went into storage.

In 1988, however, NASA retrieved the F-16XLs for use as high-performance research aircraft. Operating out of the Dryden Flight Research Center at Edwards AFB, they were both used as part of a program whose objective was to improve laminar, or smooth, airflow on aircraft flying at sustained supersonic speeds. As the F-16XL had begun back in 1977, the object was to investigate laminar flow at speeds suggestive of those at which a high-speed commercial SST might fly. In fluid dynamics, laminar flow is characterized by high-momentum diffusion, low-momentum convection, pressure, and velocity independent from time. It is the opposite of turbulent flow. In nonscientific terms laminar flow is referred to as "smooth," while turbulent flow is "rough."

The first flights were made in 1991 and 1992 with the single-seat F-16XL retrofitted with an experimental perforated titanium active wing "glove" on the upper surface of its left wing to provide active laminar flow control. In turn, Dryden used the two-seat F-16XL to conduct a more comprehensive, two-phase research program in which the active glove went on the left wing, while a passive glove was placed on the right wing to acquire baseline data. This aircraft flew 45 test flights in 1995 and 1996, but the results were never released because all data related to laminar flow was then classified.

The single-seat F-16XL, meanwhile, was later used at Dryden, along with an SR-71, in a sonic boom research project known as the *Cranked Arrow Wing Aerodynamics Project* (CAWAP). In 1997, this F-16XL aircraft was retrofitted to serve as a testbed for a new Digital Flight Control System (DFCS).

As the test programs came to an end in 1999, both F-16XLs were returned to storage at NASA's Dryden facility. In 2007, however, NASA consulted with Lockheed Martin (which had acquired the former General Dynamics F-16 production center at Fort Worth in 1993) to conduct a feasibility study of returning the single-seat F-16XL to flight status.

EPILOGUE

In the heady years of America's aviation industry immediately following World War II, the guiding principle of military aircraft development in the United States was simply to go "higher and faster." The prevailing attitude within the aviation industry was that anything was technologically possible and, to bend the old maxim, the sky was no longer the limit.

Indeed, why should American industry not be filled with boundless optimism? American aircraft manufacturers of the 1950s accomplished the true miracle of backing their impressive technological achievements with an unmatched capability to produce exceptional aircraft in staggering quantity. That is the legacy of the people of Convair who designed and built the deltas.

In a conversation in his San Diego office in 1994, Art Veitch, Convair's General Manager, told me, "So as the buildings and equipment disappear, and the final Convair products are delivered, it is easy to lament the passing of this great company. But the people and the legacy of products that they developed and produced continue to exist. And while they do, Convair will also remain."

The Convair delta family closed out the century in fitting fashion—testing a means of traveling into space. By the time the former F-106A made that last flight, Convair itself had been resigned to the history books for two years, but the name will never be forgotten. Neither will the airplanes.

Contrails crisscross the sky as twilight finally sets on the Delta Dart at the end of its three decades of service. (Author's collection)

BIBLIOGRAPHY

Anderson, David A. "Pictures Reveal Reds' New 'Sunday Punch.'" *Aviation Week*, 15 February 1954.

——. "Congress Gets Red Plane Facts." *Aviation Week*, 22 February 1954.

Andrade, John M. *U.S. Military Aircraft Designations and Serials 1909 to 1979*. Midland Counties Publications, 1979.

Blair, K. G. *The History of Convair*. Convair Division, 1956.

Bouchard, Captain Joseph F. "Guarding the Cold War Ramparts—The U.S. Navy's Role in Continental Air Defense." *Naval War College Review*. Summer 1999.

Bradley, Robert. "Birth of the Delta Wing." *American Aviation Historical Society Journal*. Winter 2003.

Dabrowski, Hans-Peter. *Lippisch P13a & Experimental DM-1*. Schiffer Military History. 1993.

DiGregorio, Barry. "Aviation History: Interview with Frank K. 'Pete' Everest Who Flew a Bell X-2 to Record Speed of Mach 3." *Aviation History*. July 1998.

Dorr, Robert F. "Convair F-102 Delta Dagger." *Wings of Fame*. Volume 17, 1999.

——. "Convair F-106 Delta Dart." *Wings of Fame*. Volume 12, 1998.

Gunston, Bill. "Convair XFY-1 and Lockheed XFV-1." *Wings of Fame*. Volume 16, 1999.

Hansen, James. *Engineer in Charge: A History of the Langley Aeronautical Laboratory, 1917–1958*.

Hehs, Eric "Beryl Arthur Erickson, Test Pilot." *Code One Magazine*. October 1992.

Johnsen, Katherine. "Twining Warns of Red Jet Striking Power." *Aviation Week*, 22 March 1954.

Knaack, Marcelle Size. *Encyclopedia of US Air Force Aircraft and Missile Systems, Vol 1: Post World War II Fighters, 1945–1973*. Office of Air Force History, U.S. Government Printing Office. 1978.

McNamara, Robert (with Brian VanDeMark.) *In Retrospect: The Tragedy and Lessons of Vietnam*. Times Books. 1995.

Time Magazine: 16 February 1953; 14 June 1954; 15 November 1954.

Wagner, Ray. *American Combat Planes, Third Enlarged Edition*. Doubleday. 1982.

Wegg, John. *General Dynamics Aircraft And Their Predecessors*. Naval Institute Press. 1990.

Yenne, Bill. *Convair: Into the Sunset*. Greenwich Publishing. 1995.

——. "Convair B-58 Hustler." *International Air Power Review*, Volume 2, 2001.

GLOSSARY

ABM - Anti-Ballistic Missile
ADC - Air Defense Command
ADI - Attitude Director Indicator
ADIZ - Air Defense Identification Zone
ADVON - Advanced Echelon
AFCRL - Air Force Cambridge Research Laboratories
AFFTC - Air Force Flight Test Center
AFRL - Air Force Research Laboratory
AFSC - Air Force Systems Command
ALBM - Air-Launched Ballistic Missile
ALCM - Air-Launched Cruise Missile
AMI - Airspeed-Mach Indicator
AMRAAM - Advanced Medium-Range Air-to-Air Missile
AMTI - Airborne Moving Target Indicator
ATA - Automatic Target Acquisition
AVVI - Altitude-Vertical Velocity Indicator
AWCS - Automatic Weapon Control System
BRFICON - Broadcast Fighter Control
CIA - Central Intelligence Agency
CINC - Commander In Chief
CVAC - Consolidated Vultee Aircraft Corporation
DFS - Deutsches Forschungsinstitut fur Segelflug
DSO - Defensive Systems Operator
FCF - Functional Check Flight
FIS - Fighter Interceptor Squadron
FSAT - Full-Scale Aerial Target
GASP - Global Air Sampling Project
GIUK - Greenland-Iceland-United Kingdom (area)
GOR - General Operational Requirement
ICBM - Intercontinental Ballistic Missile
IRBM - Intermediate-Range Ballistic Missile
LRIX - Long Range Interceptor, Experimental
MEISR - Minimum Essential Improvement in System Reliability
MOL - Manned Orbiting Laboratory
MRBM - Medium-Range Ballistic Missile
MTA - Manual Target Acquisition
NACA - National Advisory Committee on Aeronautics
NASA - National Aeronautics & Space Administration
NATO - North Atlantic Treaty Organization
NORAD - North American Air Defense
PACAF - Pacific Air Forces
PACCS - Post-Attack Command & Control
PARD - Pilot Airborne Recovery Device
RAF - Royal Air Force
RAAF - Royal Australian Air Force
RCA - Radio Corporation of America
ROTC - Reserve Officer Training Corps
SAC - Strategic Air Command
SAG - Scientific Advisory Group
SAGE - Semi-Automatic Ground Environment
SLAR - Side-Looking Airborne Radar
SLIM - Simplified Logistics and Improved Maintenance (Program)
SMART - Supersonic Military Air Research Track
SNV - Scout Trainer, Vultee
STOL - Short Takeoff and Landing
STOVL - Short Takeoff and Vertical Landing
TAC - Tactical Air Command
TACAN - Tactical Air Navigation
TCP - Two-Component Pod
TDY - Temporary Duty Assignment
VTOL - Vertical Takeoff and Landing
WSEM - Weapon System Evaluator Missile
WSMR - White Sands Missile Range

INDEX

Convair Deltas: From SeaDart to Hustler tells the ompelling story of America's aerospace industry in its eyday. It was a time when manufacturers boldly took the itiative to explore futuristic designs by actually building and ying airplanes to determine how well they worked, if at all. onvair led the way with a complete family of aircraft that ncluded America's first delta-wing jet, the revolutionary F-92A, and the world's first jet-powered seaplane, the F2Y-1 SeaDart. Added to that list were the XFY-1 Pogo urboprop vertical-takeoff-and-landing (VTOL) fighter and he F-102A Delta Dagger and F-106A Delta Dart supersonic issile-firing interceptors. As a fitting finale, Convair also roduced the record-breaking four-engine B-58 Hustler—the vorld's first Mach 2 strategic bomber.

Noted aviation author Bill Yenne thoroughly documents onvair's quest to conquer the aerodynamic mysteries of the lelta wing. His stories explain the dramatic struggles and technological triumphs that gave the world som greatest fighter and bomber aircraft. While a nur these individual aircraft have been covered in othe over the years, there has never been a major work fe the detailed developmental history of all six togeth this book shows them in the proper historical contex aircraft designed for frontline operation during the C

.S. $32.95

ISBN 978-1-58007-118-5

53295

9 781580 071185

Specialty Press
39966 Grand Avenue
North Branch, MN 55056 USA
(651) 277-1400 / (800) 895-4585
www.specialtypress.com

Distributed in the UK and Europe by
Crécy Publishing Ltd

Printed in China